

THE SPACE LEADERSHIP PRESERVATION ACT AND THE NEED FOR STABILITY AT NASA

HEARING BEFORE THE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY HOUSE OF REPRESENTATIVES ONE HUNDRED FOURTEENTH CONGRESS

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February 25, 2016

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**THE SPACE LEADERSHIP PRESERVATION ACT
AND THE NEED FOR STABILITY AT NASA**

THURSDAY, FEBRUARY 25, 2016

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Committee met, pursuant to call, at 10:05 a.m., in Room 2318, Rayburn House Office Building, Hon. Lamar Smith [Chairman of the Committee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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***The Space Leadership Preservation Act and the Need for
Stability at NASA***

February 25, 2016

10 a.m. – 12 p.m.

2318 Rayburn House Office Building

Witnesses

Panel 1

The Honorable John Culberson (TX-7)

Panel 2

Dr. Michael Griffin, Former Administrator, NASA

Colonel Eileen Collins, USAF (Ret.); Commander, STS-93 and 114; and Pilot, STS-63 and 94;
and former Chair, Subcommittee on Space Operations, NASA Advisory Council

Ms. Cristina Chaplain, Director, Acquisitions and Sourcing Management, Government
Accountability Office (GAO)

**COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

The Space Leadership Preservation Act and the Need for Stability at NASA

February 25, 2016
10 a.m. – 12 p.m.
2318 Rayburn House Office Building

Purpose

At 10:00 a.m. on February 25, 2016, the Committee will hold a hearing titled “*The Space Leadership Preservation Act and the Need for Stability at NASA*” to receive testimony on legislation (H.R. 2093) first introduced in the 112th Congress and re-introduced in the 113th and the 114th Congresses. This hearing will inform the House Science, Space, and Technology Committee’s consideration of National Aeronautics and Space Administration (NASA) policies, organization, and programs.

Witnesses

Panel 1

- **The Honorable John Culberson (TX-7)**

Panel 2

- **Dr. Michael Griffin**, Former Administrator, NASA
- **Colonel Eileen Collins**, USAF (Ret.); Commander, STS-93 and 114; and Pilot, STS-63 and 94; and former Chair, Subcommittee on Space Operations, NASA Advisory Council
- **Ms. Cristina Chaplain**, Director, Acquisitions and Sourcing Management, Government Accountability Office (GAO)

Background:

On February 27, 2013, the Committee held a hearing titled “A Review of the Space Leadership Preservation Act.” The bill’s cosponsors, Reps. Frank Wolf and John Culberson testified along with Mr. Tom Young, who testified on his own behalf, and Mr. Elliott Pulham, Chief Executive Officer of the Space Foundation.

Prior to this hearing, the Space Foundation issued a report in December 2012 titled *Pioneering: Sustaining U.S. Leadership in Space*. The report noted that,

“...[a]s the space program has evolved, we have witnessed frequent redirection and constantly shifting priorities at NASA, mixed signals from Congress and the

administration, organizational conflicts, and the lack of a singular purpose, resulting in a space agency without a clear, stable direction.”¹

The report went on to find that,

“...NASA needs to embrace a singular, unambiguous purpose that leverages its core strengths and provides a clear direction for prioritizing tasks and assigning resources.”²

A more recent report from the National Research Council titled *Pathways to Exploration: Rationales and Approaches for a U.S. Program of Human Space Exploration* (June 2014), stated:

“...the human spaceflight program in the United States had experienced considerable programmatic turbulence, with frequent and dramatic changes in program goals and mission plans in response to changes in national policies. The changes had a high cost in program resources and opportunities and imposed what many feared was an intolerable burden on already constrained human exploration budgets.”³

On October 28, 2015, NASA Administrator Charles Bolden gave a speech before the Center for American Progress and stated that NASA needs a “constancy of purpose” that stretches across multiple administrations. The Administrator stated,

“...[w]e’ve got to stay focused. If we change our minds at any time in the next three or four years, which always is a risk when you go through a government transition, my belief is that we’re doomed.”⁴

The Aerospace Safety Advisory Panel (ASAP), established by Congress to report to NASA and Congress on safety issues affecting NASA, stated in their recent report last January,

“NASA faces another challenge that has historically led to disruption and inefficiency and arguably has impact on safety and good systems engineering. This is the challenge of starting over with new programs and directions following Administration change. As in prior reports, the ASAP urges constancy of purpose. Failing to stay the course with current programs of record will make it an even longer, costlier, and potentially less safe trip to Mars.”⁵

As the House Science, Space, and Technology Committee continues to advocate for the need to legislatively reauthorize NASA, this hearing will take a comprehensive look at how the agency functions, and consider legislative proposals, such as *The Space Leadership Preservation Act* (H.R. 2093), to improve NASA’s management structure and accountability.

The *Space Leadership Preservation Act* proposes a number of changes to the management structure of NASA and its procurement authority to address the issue of constancy of purpose.

¹ Available at: http://www.spacefoundation.org/sites/default/files/downloads/PIONEERING_report.pdf

² *Ibid.*

³ Available at: <http://www.nap.edu/catalog/18801/pathways-to-exploration-rationales-and-approaches-for-a-us-program>

⁴ Available at: <http://spacenews.com/bolden-nasa-doomed-if-next-president-dumps-journey-to-mars/>

⁵ Available at: http://oiiir.hq.nasa.gov/asap/documents/2015_ASAP_Annual_Report.pdf

The bill includes the following provisions:

10 Year Term for the NASA Administrator: The bill establishes a 10-year term for the Administrator of the National Aeronautics and Space Administration. The Administrator shall be chosen from a list provided by a new “Board of Directors”.

Establish a Board of Directors: The bill establishes a “Board of Directors.” It provides the manner of the selection and appointment as well as the criteria to qualify for the board and the length of each member’s term. This section empowers the board to provide to the President and Congress a proposed budget for NASA; to provide a list of nominees to the President for appointment to Administrator, Deputy Administrator, and Chief Financial Officer, all Senate confirmed appointments; to provide reports on specific policy matters deemed important by Congress; to review current space programs and future space exploration plans; and to provide a recommendation to Congress and President for the removal of the Administrator for cause.

Budget Deliberation Review: The bill directs NASA to provide the “Board of Directors” with the budget they send to the White House Office of Management and Budget (OMB), thereby allowing them to see any differences between what NASA asked for in a budget and what the Administration formally requested for NASA. The bill also requires the President to provide an explanation of any discrepancy in the budget proposal provided by the “Board of Directors.”

Long-Term Procurement: The bill provides NASA with the capability to enter into contracts for rocket propulsion systems and manned and unmanned space transportation vehicles and payloads, including expendable launch vehicles, and any other infrastructure intended for placement or operation in space or on celestial bodies, and services related thereto for periods in excess of the period for which funds are otherwise available for obligation under certain conditions.

Issues

- What are the key challenges facing NASA today?
- What organizational changes might be made to ensure more stability for our nation’s civil space program?
- Should NASA’s management structure be modeled after other agencies, such as the National Science Foundation, to provide more consistency in goals and constancy of purpose?

Chairman SMITH. The Committee on Science, Space, and Technology will come to order. And without objection, the Chair is authorized to declare recesses of the Committee at any time.

Welcome to today's hearing entitled "The Space Leadership Preservation Act and the Need for Stability at NASA."

I'll recognize myself for an opening statement and then the Ranking Minority Member, Ms. Eddie Bernice Johnson from Texas.

And let me say just looking out on the audience today I'm glad to see so much interest in this subject. And we have actually two panels today. We're going to start off with Congressman John Culberson, and then we'll go to a panel of three witnesses after that.

Presidential transitions often have provided a challenge to NASA programs that require continuity and budget stability. But few have been as rocky as the Administration change we experienced seven years ago.

Even before he was elected President, then-candidate Barack Obama planned to delay the Constellation program being built to take humans to deep space destinations. One of the Obama Administration's first acts, in fact, was to cancel this NASA program outright.

These jarring decisions have been accompanied by repeated budget proposals that continue to cut key programs designed to take humans to deep space destinations like the Moon and Mars. The most recent proposal released just a few weeks ago would shrink the Space Launch System and Orion crew vehicle by more than \$800 million. Even worse, the entire budget depends on make-believe budget gimmicks.

This regrettable approach continues to make a Mars mission all but impossible. It is not the approach of an administration that is serious about maintaining America's leadership in space.

The recent report from the National Academies of Science titled "Pathways to Exploration: Rationales and Approaches for a U.S. Program of Human Space Exploration," stated that: "The human spaceflight program in the United States had experienced considerable programmatic turbulence, with frequent and dramatic changes in program goals and mission plans in response to changes in national policies. The changes had a high cost in program resources and opportunities, and imposed what many feared was an intolerable burden on already-constrained human exploration budgets."

The Aerospace Safety Advisory Panel, an advisory body established by Congress to report to NASA and Congress on safety issues that affect NASA, stated in their recent report in January that "NASA faces another challenge that has historically led to disruption and inefficiency and arguably has impact on safety and good systems engineering. This is the challenge of starting over with new programs and directions following administration change. As in prior reports, the ASAP urges constancy of purpose. Failing to stay the course with current programs of record will make it an even longer, costlier, and potentially less safe trip to Mars."

These facts are not lost on this committee. The most recent NASA Authorization Act from 2010 contains several provisions that remain the "law of the land" and continue to guide NASA activities.

The Act notes that the “commitment to human exploration goals is essential for providing the necessary long-term focus and programmatic consistency and robustness of the United States civilian space program.”

The Act states that “It is in the United States’ national interest to maintain a government-operated space transportation system for crew and cargo delivery to space.”

The Act directs that “The United States must develop as rapidly as possible replacement vehicles capable of providing both human and cargo launch capability to low-Earth orbit and to destinations beyond low-Earth orbit.”

The 2005, 2008, and 2010 NASA Authorization Acts are consistent in their direction to NASA. NASA needs the same certainty from the executive branch that it receives from Congress. Today, we are discussing how to provide that stability to NASA once again as we look toward a presidential transition in less than a year.

My friend and Texas colleague, Representative John Culberson, has a bill that seeks to do just that. I thank Representative Culberson for his leadership on this issue, and I am a cosponsor of his legislation. We share the goal of providing NASA with long-term, consistent support, and it is great to have him here today to discuss his bill.

One of the first hearings that this committee held during my chairmanship was, in fact, on this very topic.

I look forward to hearing from our witnesses today how we can ensure stability in our space program through the next presidential transition.

Dr. Michael Griffin provides a unique perspective as the last NASA Administrator to serve before a presidential transition. Colonel Eileen Collins not only has served as a pilot and commander of space shuttle missions, but also as a member of the NASA Advisory Council during the last transition. And Ms. Cristina Chaplain brings the Government Accountability Office’s insightful perspective.

We look forward to hearing their testimony and learning how we can ensure that NASA remains on the forefront of space exploration through the next presidential transition.

[The prepared statement of Chairman Smith follows:]



COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
February 25, 2016

Media Contact: Laura Crist
(202) 225-6371

Statement of Chairman Lamar Smith (R-Texas)

The Space Leadership Preservation Act and the Need for Stability at NASA

Chairman Smith: Presidential transitions often have provided a challenge to NASA programs that require continuity and budget stability. But few have been as rocky as the administration change we experienced seven years ago.

Even before he was elected president, then-candidate Barack Obama planned to delay the Constellation program being built to take humans to deep space destinations. One of the Obama administration's first acts, in fact, was to cancel this NASA program outright.

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"NASA faces another challenge that has historically led to disruption and inefficiency and arguably has impact on safety and good systems engineering. This is the challenge of starting over with new programs and directions following administration change. As in prior reports, the ASAP urges constancy of purpose. Failing to stay the course with current programs of record will make it an even longer, costlier, and potentially less safe trip to Mars."

These facts are not lost on this Committee. The most recent NASA Authorization Act from 2010 contains several provisions that remain the "law of the land" and continue to guide NASA activities:

- The Act notes that the "commitment to human exploration goals is essential for providing the necessary long-term focus and programmatic consistency and robustness of the United States civilian space program."
- The Act states that "it is in the United States national interest to maintain a government operated space transportation system for crew and cargo delivery to space."
- The Act directs that "the United States must develop as rapidly as possible replacement vehicles capable of providing both human and cargo launch capability to low-Earth orbit and to destinations beyond low-Earth orbit."

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Chairman SMITH. That concludes my opening statement, and the Ranking Member is recognized for hers.

Ms. JOHNSON. Thank you very much, Mr. Chairman, and good morning. I'd like to start by welcoming our witnesses.

NASA is a cornerstone of our nation's R&D enterprise, a source of inspiration to our young people, and a worldwide symbol of America's technological prowess and dedication to the peaceful exploration of space. We want it to succeed.

Today's hearing is entitled "The Space Leadership Preservation Act and the Need for Stability at NASA." While I have concerns about the legislation itself, I wholeheartedly agree with the premise that we want to preserve America's leadership in space, and that NASA will need stability if it is to maintain that leadership role. I am heartened that Chairman Culberson has long felt the same way.

That said, I regret that the legislation being discussed today, while obviously well-intentioned, unfortunately is not likely to fix the fundamental causes of instability at NASA. Let me give just a few examples of my concern with what the bill does and doesn't do.

First, the bill would establish a Board of Directors apparently modeled after the National Science Foundation's National Science Board. Of course, NSF and NASA are quite different agencies with quite different missions. So the applicability of the NSF model to NASA is unclear.

But there are other differences that also need to be noted. As we know, the members of the NSB are all nominated by the President. The Board of Directors established in this bill, on the other hand, would have a majority of its members named by Congress using a formula that injects partisan politics into a board that ostensibly is supposed to insulate NASA from politics.

In addition, the Board would be tasked with preparing the budget for NASA in parallel with NASA's own budget preparations process. This seems to be a prescription for wasteful duplication at best, with the potential for serious confusion and instability as the more likely outcomes.

It is unclear to me how this small group of individuals with no agency management responsibilities or accountability is supposed to develop a detailed budget for a \$19 billion agency without having to set up an unwieldy competing administrative infrastructure of its own. This is an approach that will not lead to a good outcome.

Instead, we should let the dedicated men and women at NASA who are tasked with carrying out NASA's challenging programs be the ones to develop its budget requests. It should not be done by a group of individuals who, though may be talented, will not have any accountability for delivering results under the budget they may propose. If we're concerned that OMB is adjusting NASA's budget request in unhealthy ways, then we in Congress already have sufficient oversight and budgetary tools at our disposal to correct that situation.

Next, the bill would establish a fixed ten-year term for the NASA Administrator. I frankly don't know what problem this provision is intended to correct. A mission agency benefits from having an administrator chosen by the President or she—that he or she serves.

Having a carryover administrator from a previous President's term will do nothing to ensure stability if the President wishes to pursue a different policy agenda from his or her predecessor and doesn't see the Administrator as being part of his or her team.

In addition, as history shows, having a fixed term for an agency head means little in practice. Only 5 of the last 15 NSF Directors served out a full six-year term, and similar instability has been the norm for FAA despite the five-year term for its Administrators.

I could go on, but the reality is that we don't need to set up a new bureaucracy outside of NASA or alter the appointment process for its leaders. If we're interested in ensuring stability at NASA, it is already in our power as Congress to do so. We are the ones who ultimately determine NASA's budget. We can provide the necessary budgetary stability to NASA or we can destabilize it with appropriation delays, continuing resolutions, and shutdowns. The choice is ours. It's right here in this Committee.

In addition, we have the ability to set a stable direction for NASA, and we did just that in the 2015 NASA reauthorization bill that passed the House. We see that Mars should be the goal of our human exploration program. The President has agreed, though that was determined before he became President. We should take that consensus and build on it rather than having an unelected board put forth its own exploration vision every four years.

The two Congressional actions that I have just described, one budgetary and one policy-oriented, will do more to maintain space leadership and ensure stability at NASA than anything we might do in this bill that we are discussing today.

So in closing, I again want to welcome our witnesses. I appreciate your service, and I look forward to your testimony. Mr. Chairman, I yield back.

[The prepared statement of Ms. Johnson follows:]

OPENING STATEMENT

Ranking Member Eddie Bernice Johnson (D-TX)

House Committee on Science, Space, and Technology
Full Committee

"The Space Leadership Preservation Act and the Need for Stability at NASA"
February 25, 2016

Good morning. I would like to start by welcoming our witnesses to today's hearing. None of you are strangers to our Committee, and we always welcome your insights.

I would especially like to welcome my fellow Texan and friend, Chairman John Culberson, who I know shares my passion for NASA and the great things that it accomplishes for our nation. I would like to emphasize that fact. I believe that all Members of this Committee—and our witnesses—share my belief that NASA is a cornerstone of our nation's R&D enterprise, a source of inspiration for our young people, and a worldwide symbol of America's technological prowess and dedication to the peaceful exploration of space. We want it to succeed.

Today's hearing is entitled "*The Space Leadership Preservation Act and Need for Stability at NASA*." While I have concerns about the legislation itself, I wholeheartedly agree with the premise that we want to preserve America's leadership in space, and that NASA will need stability if it is to maintain that leadership role. I am heartened that Chairman Culberson has long felt the same way.

That said, I regret that the legislation being discussed today, while obviously well intentioned, unfortunately is not likely to fix the fundamental causes of instability at NASA. Let me give just a few examples of my concerns with what the bill does—and doesn't—do. First, the bill would establish a "Board of Directors", apparently modeled after the NSF's National Science Board. Of course, NSF and NASA are quite different agencies, with quite different missions, so the applicability of the NSF model to NASA is unclear. But there are other differences that also need to be noted.

As we know, the members of the NSB are all nominated by the President. The Board of Directors established in this bill, on the other hand, would have a majority of its members named by Congress using a formula that injects partisan politics into a Board that ostensibly is supposed to insulate NASA from politics.

In addition, the Board would be tasked with preparing a budget for NASA, in parallel with NASA's own budget preparation process. This seems to be a prescription for wasteful duplication at best, with the potential for serious confusion and instability as the more likely outcomes.

It is unclear to me how this small group of individuals—with no agency management responsibilities or accountability—is supposed to develop a detailed budget for a 19 billion dollar agency without having to set up an unwieldy, competing administrative infrastructure of its own. This is an approach that will not lead to a good outcome. Instead, we should let the

dedicated women and men at NASA who are tasked with carrying out NASA's challenging programs be the ones who develop its budget request. It should not be done by a group of individuals who, talented as they may be, will have no accountability for delivering results under the budget they may propose. If we are concerned that OMB is adjusting NASA's budget request in unhealthy ways, then we in Congress already have sufficient oversight and budgetary tools at our disposal to correct the situation.

Next, the bill would establish a fixed, 10-year term for the NASA Administrator. I frankly don't know what problem this provision is intended to correct. A mission agency *benefits* from having an Administrator chosen by the President he or she serves. Having a carryover Administrator from a previous President's term will do nothing to ensure stability if the President wishes to pursue a different policy agenda from his or her predecessor and doesn't see that Administrator as being part of his or her "team". In addition, as history shows, having a fixed term for an agency head means little in practice—only 5 of the last 15 NSF Directors served out a full six year term, and similar instability has been the norm at FAA, despite a five year term for its Administrators.

I could go on, but the reality is that we don't need to set up a new bureaucracy outside of NASA or alter the appointment process for its leaders. If we are interested in ensuring stability at NASA, it is already in our power as Congress to do so. We are the ones who ultimately determine NASA's budget. We can provide the necessary budgetary stability to NASA—or we can destabilize it with appropriations delays, continuing resolutions, and shutdowns. The choice is ours. In addition, we have the ability to set a stable direction for NASA. And we did just that in the 2015 NASA Authorization bill that passed the House. We said that Mars should be the goal of our human exploration program. The President has agreed. We should take that consensus and build on it, rather than having an unelected Board put forth its *own* exploration vision every four years. The two congressional actions that I have just described—one budgetary and one policy-oriented—will do more to maintain space leadership and ensure stability at NASA than anything we might do in the bill we are discussing today.

In closing, I again want to welcome our witnesses, I appreciate your service, and I look forward to your testimony.

Chairman SMITH. Thank you, Ms. Johnson.

Our witness on the first panel today is Hon. John Culberson, Chairman of the House Appropriations Subcommittee on Commerce, Justice, and Science.

Congressman Culberson represents the 7th District of Texas, a district formerly represented by President George H.W. Bush. A longtime space enthusiast, Chairman Culberson is the sponsor of H.R. 2093, the Space Leadership Reservation Act of 2015. We thank him for being here this morning and look forward to hearing about his bill.

And the gentleman is recognized for five minutes. John, make sure your mike is on there.

**TESTIMONY OF HON. JOHN CULBERSON (TX-7),
U.S. HOUSE OF REPRESENTATIVES**

Mr. CULBERSON. Thank you.

Chairman SMITH. Okay.

Mr. CULBERSON. I want to thank you, Chairman Smith and Ranking Member Johnson, for holding this hearing today to review the Space Leadership Preservation Act of 2015. I also want to thank your staff, particularly Chris Shank and Tom Hammond, for working with me and my staff on this important legislation.

Chairman Smith, thank you for supporting this bill as an original cosponsor. I'm deeply grateful for your confidence and support on this important matter. And I also want to thank your fellow Committee Members, Representatives Sensenbrenner, Posey, and Bridenstine, for their support as cosponsors.

I especially want to thank my predecessor Congressman Frank Wolf, who chaired the Commerce, Justice, Science Committee, in helped me develop this legislation originally because Frank saw, as I have, as all of you have, that we simply have to give NASA greater stability. We need to make this agency less political, more professional, and give them the ability to see far into the future with the knowledge and with the confidence that the Congress will be there behind them.

I have some of my very best memories as a boy growing up in Houston. I've been to the space program. All my earliest heroes were the Apollo astronauts. I got my first telescope for Christmas when I was 12. I've had one ever since, bought myself a rather large telescope as a high school graduation present. These men and women have been heroes to all Americans.

And when I was assigned to the Appropriations Committee, I asked but one thing. I wanted to be—to serve on the Commerce, Justice, Science Committee and one day be there to share it. And it's an extraordinary privilege for me to work with you, Mr. Chairman, Ranking Member Johnson, all the Members of this Committee, as we do our best arm-in-arm in—to make sure that NASA has the funding, the support that they need to do all that's on their plate.

In the appropriations bill that the Congress just approved—I made certain that NASA has today the largest appropriation that they have ever received since the agency was created in 1958, and I will continue to make sure that NASA has the resources they need to accomplish all that is before them. And that again is a

year-to-year effort. That is again something that tends to be reliant too much on who is in the White House and who holds the chairmanships of these important subcommittees.

I also want to be sure to thank my counterpart in the Senate, Senator Richard Shelby, who chairs the Senate Commerce, Justice, Science Committee. He's an ardent supporter of the space program, and it's been absolutely vital to have him there for his support.

You know, although it's been over 44 years since any human has set foot on the surface of another celestial body, when Gene Cernan, my constituent and good friend, and Harrison Schmitt left the moon after three days exploring the Taurus-Littrow lunar valley, mission control in Houston read a statement from the White House to the Apollo 17 astronauts that said, "As the Challenger leaves the surface of the moon, we are conscious not of what we leave behind but of what lies before us." But today, the glory days of the Apollo program seem to be behind us, and the country seems to have lost focus on exploring what lies before us, or all the wonder that would be, as Tennyson said so well.

The team at NASA unfortunately has faced program cancellation after program cancellation. And as Mike Griffin points out so correctly in his testimony you'll hear in a moment—Dr. Griffin points out, "As the year 2009 opened, we had a plan for our nation's space program, a plan of generational scope for what it was that NASA expected to do." But by early 2010, barely a year later, this carefully hewn strategy that had been approved twice by Congress in two successive authorization acts of 2005 and 2008, Dr. Griffin points out, had been abandoned and cancelled.

And I have a chart here that I'll make sure each one of you have a copy of that.

[Slide.]

Mike Coats, the Director at the Johnson Space Center first pointed out to me that this is the fundamental problem at NASA, that in the last 20 years, NASA has spent more than \$20 billion on cancelled development programs. No entity, no company, no entity, no agency of the federal government, no agency of any state government or local government can function in this environment. And think of the heartbreak.

Brian Babin, my good friend and colleague from the east side of Houston, represents the Johnson Space Center. We all know the heartbreak that those great men and women, those brilliant engineers and scientists who have devoted their life to making the dreams of the future come true, to build these incredible machines, these great rockets and spacecraft, they pour their heart and soul into it only to have it yanked out from underneath them. That is very, very damaging to their morale and destructive to our program as a whole.

This is not a partisan issue. Completely set politics aside. Now, forget who's in the White House, what party label. It's just intensely destructive, and we cannot continue. It's wasteful, damaging, and it damages our ability as a nation to preserve our leadership in space. And space is the high ground. I cannot imagine General Meade at Gettysburg abandoning Little Round Top, just giving it over. You do not surrender the high ground. And yet I'm very concerned that in the absence of stability, in the absence of

giving NASA a greater level of professionalism and making them less political, that the country is going to wind up abandoning the high ground.

There is no clear mission today, and we simply have to come up with a way to get the agency the ability to give us that vision, and with the guidance and support of Congress, make that come true.

I had the chance, the honor recently to hear former Navy SEAL Robert O'Neill speak about his work in identifying and taking out Osama bin Laden, and one of the things that really stuck with me from Rob's remarks was he said that a lack of a clear mission hurts morale. That's true of all of us as human beings, and it's certainly true with the team at NASA. We can help fix that problem with this legislation.

I have welcomed suggestions or ideas on how we can modify the legislation, but I put a lot of thought into this. With your help, Chairman Smith and Chairman Frank Wolf, we looked at the—some of the models in government that work well. The Director of the FBI, for example, has—that—the ten-year term for the Director of the FBI is serving very well. We know that the FBI is a pillar of integrity, and that Director does not think about politics or who the President is. They focus on enforcing the law and doing the right thing for the right reasons for the country.

Whether it is the President, Ms. Johnson, or whether it's the Congress, your human nature being what we are, there's going to be politics either way. And the idea of the Board of Directors was to make sure that we had members from both parties recommending appointments to that board, who would have to then be submitted by the President to the Senate for confirmation, preserving the separation of powers and the Executive's role in making that appointment so there are no constitutional issues, and you also have both parties in both Houses of Congress having an impact on that Board of Directors.

The idea of the budget being submitted directly to Congress is important because if—we don't all of us—none of us know exactly what NASA's best minds have recommended. They submit their budget to the Office of Management and Budget, and the budget that we get, Mr. Chairman, and the budget that I receive—the budget recommendation from the President is not really from NASA. It's from OMB. As a practical matter, we all know that OMB runs NASA today. The bureaucrats, the bean-counters at OMB are the ones making the big decisions for our nation's space program. And it's just unacceptable.

I'd like to know, as I know you would, an honest, accurate number. What do the best minds at NASA recommended to the Congress? What's necessary for you to achieve all that's before you? And that's the idea behind the direct budget submission, Ms. Johnson, that we would, as Members of Congress, receive budget submissions from the Board of Directors at NASA. We would also get OMB's recommendation. Then we can lay them down side by side and see what is necessary to make those dreams of the future come true and balance them and figure out what is necessary for American taxpayers to fund that recommendation.

That longer term for the Administrator, I think, is not only necessary for stability to make the agency head less political, but to

give that individual the time to make sure that these tremendously complicated and expensive spaceflight programs come to fruition so we don't see this start and stop, as you see on this chart right here.

[Slide.]

Finally, Mr. Chairman, I really think that from my experience working in the Congress, I started out here on this Committee, and then when I went to the Appropriations Committee and was able to see, as you have, the extraordinary men and women at NASA who are so dedicated to make sure that the American space program is the best on earth, who are so dedicated to make sure that the spacecraft and the rockets they build are truly the best that have ever been conceived or built by human hands.

I keep coming back to the fundamental problem. The cause of the instability is governance. We could continue to fund NASA. We can continue down this path of year-to-year pillar-to-post funding, or we could make fundamental long-term changes that our successors will inherit an agency that is less political, more professional, more stable, more focused on making the dreams of the future come true, more focused on achieving the goals of the Decadal Survey.

Quite frankly, I wish one thing that you could add, I'd like to figure out a way to have a human spaceflight Decadal Survey. The scientists at the National Academy of Sciences do a great job when they prepare the Decadal Survey for astrophysics, for earth sciences, for heliophysics, for planetary science. And you'll see in my CJS bill I wired in there that NASA shall follow the recommendations of the Decadal Survey as they prepare what is necessary for missions in the future, and I made certain they got the money to do it.

But what I can't figure out and resolve is how do you have a Decadal Survey for human spaceflight without having all those conflicting passions from the different contractors that are involved? That's a challenge that I'd ask for the help of the Science Committee in resolving.

But it is governance. It all circles back to governance. And if we want to ensure that America maintains its leadership role in outer space, if we want to make sure that we are protecting the high ground and that our children and grandchildren will live to see interstellar flight, that they'll live to see the discovery of life on other worlds, I encourage you, urge you to join me in passing this legislation and modifying it. Make it better, and help us find a way to give NASA the stability that they need at headquarters, again, to make those dreams of the future come true.

And I thank you very much for having me here today.

[The prepared statement of Mr. Culberson follows:]

Congressman John Culberson
Testimony before the Science Space and Technology Committee
Space Leadership Preservation Act and the Need for Stability at NASA
10:00AM February 25, 2016

Thank you Chairman Smith and Ranking Member Johnson for scheduling this hearing to review the *Space Leadership Preservation Act of 2015* (H.R. 2093). I am especially thankful to your staff – especially Chris Shank and Tom Hammond, for working with me on this important bill.

I'd also like to thank Chairman Smith for his support as an original cosponsor of this legislation. And, I'd like to thank Committee members Sensenbrenner and Bridenstine for their support as cosponsors.

It is a privilege to be here with you today to discuss the need for stability at NASA.

Some of my earliest and best memories are of the space program. The excitement of the Apollo missions inspired me to get my first telescope when I was 12, and I have been hooked on space ever since.

As the new chairman of the Commerce, Justice and Science Appropriations Subcommittee, and a native Houstonian, one of my goals is to restore NASA to the glory days of the Apollo program. I am very proud that the final fiscal year 2016 appropriations bill included \$19.285 billion in funding for NASA. But, increased funding is not enough.

It has been nearly 44 years since any human has set foot on the surface of another celestial body. When Gene Cernan and Harrison Schmitt left the moon after three days exploring the Taurus-Littrow lunar valley, Mission Control in Houston read a statement from the White House to the Apollo 17 astronauts – “as the Challenger leaves the surface of the moon, we are conscious not of what we leave behind, but of what lies before us.”

But today, the glory days of the Apollo program are long gone and we have lost focus on exploring “what lies before us.” The team at NASA has faced program cancellation after program cancellation. Our space program is so off track that we have to depend on Russia for transport to the International Space Station.

This is not a partisan issue.

Over the last 30 years, NASA programs have been cancelled due to cost-overruns, mismanagement or abrupt program changes at the start of each new administration. In the past 20 years alone, 27 programs have been cancelled resulting in over \$20 billion wasted on uncompleted programs. That is unacceptable. Our space program is too important to continue on this path.

We need to improve morale at NASA, and come up with long-term missions that will inspire tomorrow's 12 year olds to purchase their own telescopes and study the stars.

I recently had the honor of hearing former Navy SEAL Robert O'Neill speak about his work as a SEAL. On May 2, 2011, Rob and his team took place in a raid in Pakistan. During the raid, Rob shot Osama bin Laden three times in the head. Rob's pride in his fellow SEALs was apparent as he told their story. He described how they train together and work to communicate effectively with one and other. One of the things that stuck with me from Rob's remarks was when he said that **a lack of a clear mission hurts morale**.

That is true for any team. Including the team at NASA.

NASA's dedicated employees are incredibly smart, but over the years a lack of clear mission has worn down morale at many NASA centers.

Today, if you were to ask any NASA employee, astronauts, scientists, engineers, or contractor, what the agency's top mission is, you would probably get a confused look and several different answers – everything from asteroid retroviral missions to returning to the moon to going to Mars.

This lack of direction is not the fault of NASA employees, and it is not the fault of this Administration. It is the result of a flawed governance structure at NASA.

The bill we are discussing today will improve our space program and improve morale at NASA centers by ensuring that we take the politics out of science and provide NASA with clear direction and guidance that outlasts the political whims of any one presidential administration – and the political whims of Congress.

The reforms in the bill draw on the best practices of other agencies.

For example, the ten-year term for a NASA Administrator proposed in the bill is modeled after the term for the Director of the FBI. A longer term for a NASA Administrator will keep an Administrator in place long enough to be held accountable for long-term projects.

The idea for a Board of Directors is based on the National Science Board and similar boards in the FBI.

The direct budget submission to Congress would be similar to the NCI bypass budget and would allow the best and brightest scientists to come directly to Congress with an honest budget submission for what is necessary to achieve those goals.

"What lies before us" is limitless, and I think if we make the changes I've proposed in the *Space Leadership Preservation Act* we will allow the rocket scientists and engineers and astronauts at NASA who have devoted their lives to exploring space the opportunity to help restore our space program to the glory days of the Apollo program so that America can continue leading the world in space exploration for decades to come.

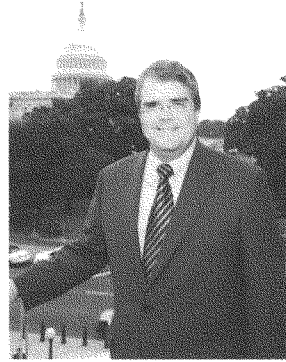
I am honored to be here with you today and appreciate your time and attention to this legislation.

Thank you. Mr. Chairman, I yield back.

The Honorable John Culberson (TX-7)

As a fiscally conservative "Jeffersonian Republican," Congressman John Culberson is committed to Thomas Jefferson's vision of limited government, individual liberty, and states' rights. Simply put, John Culberson believes in "Letting Texans Run Texas."

John Culberson was elected in 2000 to represent the 7th District, a seat formerly held by President George H. W. Bush and House Ways and Means Committee Chairman Bill Archer. In Congress, John's priorities include restoring the 10th amendment; strengthening the economy by cutting taxes, creating jobs, and balancing the budget, securing the border, advancing medical and scientific research, and improving Houston transportation.



John is a member of the House Appropriations Committee, which is responsible for funding the federal government. His position on the committee allows him to rein in federal spending and promote less federal regulation and more local control. His subcommittee assignments include the Commerce, Justice, Science (CJS) Subcommittee, Homeland Security Subcommittee, and the Transportation Housing & Urban Development Subcommittee.

In November 2014, John was selected to lead the CJS Subcommittee, which oversees the Department of Commerce, the Department of Justice, the National Aeronautics and Space Administration (NASA), the National Science Foundation, and other related agencies. As Chairman, John is committed to ensuring that the Attorney General respects the rule of law and providing America's law enforcement officers with the resources they need to protect our lives and property.

As a long-time space-enthusiast and NASA advocate, one of John's top priorities is to see NASA return to its core mission of scientific research so that America remains the world-leader in space exploration. He is also a zealous advocate for increasing national investment in medical and scientific research, and recognizes that breakthroughs in these areas are vital to the economic and technological challenges we face in the 21st century.

He believes the lawlessness on the border requires immediate action, and in close cooperation with the Texas Border Sheriffs' Coalition, he continues to secure federal funding for the sheriffs to enforce existing law and provide the necessary support for our Border Patrol agents.

John also believes in cost-effective transportation projects that reduce congestion on Houston's busy freeways. His signature transportation project, the Katy Freeway expansion, is the nation's first combination Interstate highway with locally-owned toll lanes. The project was finished years ahead of schedule, and according to TxDOT has cut travel time in half.

A life-long Texan, John Culberson earned his Bachelor of Arts degree in History from Southern Methodist University in Dallas in 1981. After college, he worked for his father's political consulting and advertising agency before earning a Juris Doctorate degree from South Texas College of Law in Houston. Before his

election to Congress, he practiced law as a civil defense attorney with the Houston firm Lorange and Thompson.

In 1986, John was elected to the Texas House of Representatives while he was a law student. He spent 14 years in the Texas House and in his last term in 1999, he was selected by his peers to serve as Minority Whip. He is best remembered in Austin for his successful effort to restore state control of the Texas prison system from a federal judge. After introducing and passing legislation in the Texas House, and drafting key pieces of federal law, John fought in court on behalf of his legislation and the ruling returned full authority over state prisons to the Texas Legislature.

John and his wife, Belinda, have been married over 20 years and have an 19 year old daughter, Caroline. They are members of Memorial Drive United Methodist Church.

Chairman SMITH. Chairman Culberson, thank you for the comments about your bill and also thank you for all you have done for NASA over the years and into the future as well.

You are welcome to join us up here if you'd like to, to listen to the next expert panel. And we're going to take a brief recess while the witness table is prepared for the next panel.

Mr. CULBERSON. Thank you very much, Mr. Chairman.

Chairman SMITH. And while we're taking a recess, I understand that the gentleman from Texas, Mr. Babin, the Chairman of the Space Subcommittee, is recognized for an opening statement if he'd like to make one.

Mr. BABIN. Thank you, Mr. Chairman.

Good morning. It's a great pleasure to be here this morning with our esteemed colleague and our first witness, as we just heard, Chairman John Culberson.

And I represent the 36th District of Texas, which is the home of the Johnson Space Center. I've had the privilege of visiting JSC on a number of occasions. Every time I stop by there, I am reminded of the truly extraordinary accomplishments that we have made as a nation. I am also inspired by the potential that exists at NASA to continue expanding our horizons deeper into space. It's truly an awe-inspiring mission that is pursued with dedication by NASA's personnel and its contractors.

Space exploration and science captures the American people's interests, it inspires us to pursue extraordinary goals, and keeps us on the forefront of scientific achievement. It is a challenging endeavor that distinguishes the United States as a global leader. It supports innovation and economic growth, and inspires the next generation to build, explore, and discover.

The missions of NASA that we should be focused on are complex, they are expensive, and they are long term. Unfortunately, the last eight years have been characterized by turmoil, and by upheaval and uncertainty. If there's anything that we have learned from this experience, it is that our national space program can ill-afford to change our program of record every time that there is a new President. Space exploration requires stability and unwavering dedication.

Chairman Culberson, a strong supporter and good friend of our nation's space program, has been vocal, as you heard this morning, about how the billions of dollars have been dedicated, directed, and redirected over the years with fits and starts of various NASA projects. Your pursuit of a solution to this challenge, Representative Culberson, is greatly appreciated by me and many of our colleagues.

Space exploration is a very worthwhile investment for the taxpayer and for the Nation. It inspires the next generation of explorers to pursue science, technology, engineering, and math; it advances U.S. soft power and international relations; it reinforces our aerospace industrial base; increases economic competitiveness; and advances our national security interests.

There's a great deal of promise in the future of space, but if we fail to provide stability for NASA's space exploration programs, we may well lose our leadership in space. Make no mistake, other nations are nipping at our heels and we can ill-afford to rest on our

laurels. Losing U.S. leadership in space will significantly undermine our national interests, erode our industrial base, undermine our international influence, and cause the loss of a skilled workforce and will jeopardize our national security. Our colleague Bill Posey often says that the Chinese are going to the moon, and they're not going there just to collect rocks, and I couldn't agree more.

Mr. Culberson's Space Leadership Preservation Act offers us an opportunity to review many of the challenges facing our nation's space agency. There may be many ways to achieve the goals of this legislation, and so I have an open mind. Presidential elections offer both challenges and opportunities, and that's why it is imperative that our colleagues in the Senate consider the bipartisan NASA Authorization Act that passes via unanimous consent over a year ago. They must bring this up. NASA would be well-served by the guidance that legislation provides. It would provide stability of purpose in an uncertain time. All that they would have to do is update the funding levels to match the recently passed Omnibus Appropriations levels for NASA.

And I appreciate hearing the testimony of Representative Culberson and looking forward to hearing our other distinguished witnesses this morning, and I thank them for appearing here.

And with that, I yield back, Mr. Chairman.

[The prepared statement of Mr. Babin follows:]



COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
February 25, 2016

Media Contact: Laura Crist
(202) 225-6371

Statement of Space Subcommittee Chairman Brian Babin (R-Texas)
The Space Leadership Preservation Act and the Need for Stability at NASA

Chairman Babin: Thank you Mr. Chairman. Good morning. It is a pleasure to be here today and with our esteemed colleague and our first witness, Representative John Culberson.

I represent the 36th district of Texas, the home of the Johnson Space Center (JSC). I have had the privilege of visiting JSC on a number of occasions. Every time I stop by, I am reminded of the truly extraordinary accomplishments we've made as a nation. I am also inspired by the potential that exists at NASA to continue expanding our horizons deeper into space. It is truly an awe inspiring mission that is pursued with dedication by NASA's personnel and its contractors.

Space exploration and science captures Americans' interests, it inspires us to pursue extraordinary goals, and keeps us on the forefront of scientific achievement. It is a challenging endeavor that distinguishes the United States as a global leader, supports innovation and economic growth, and inspires the next generation to build, explore, and discover.

The missions that NASA should be focused on are complex, they are expensive, and they are long term. Unfortunately, the last eight years have been characterized by turmoil, upheaval, and uncertainty. We cannot change our program of record every time there is a new President. We cannot speed up development or change course overnight. Space exploration requires stability and unwavering dedication.

Make no mistake; space exploration is a worthwhile investment for the taxpayer and our nation. It inspires the next generation of explorers to pursue science, technology, engineering, and math; advances U.S. soft power and international relations; reinforces our aerospace industrial base; increases economic competitiveness; and advances our national security interests.

There is a great deal of promise in the future of space. But if we fail to provide stability for NASA's space exploration programs, we may well lose our leadership in space. And other nations will happily step up. Losing U.S. leadership in space will significantly undermine our national interests, erode our industrial base, undermine our international influence, and cause the loss of a skilled workforce. I, for one, don't want that to happen on my watch.

Mr. Culberson's "Space Leadership Preservation Act" offers us an opportunity to review many of the challenges facing our nation's space agency. There may be many ways to achieve the goals of this legislation, so I have an open mind. Presidential elections offer not only challenges, but opportunities.

That is why it is imperative that our colleagues in the Senate consider the bipartisan NASA Authorization Act that passes via unanimous consent over a year ago. NASA would be well served by the guidance that legislation provides. It would provide stability of purpose in an uncertain time. All they would have to do is update the funding levels to match the recently passed Omnibus Appropriations levels for NASA.

I look forward to hearing the testimony of Representative Culberson and our other distinguished witnesses, and thank them for appear today.

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Chairman SMITH. Thank you, Mr. Babin.

We are awaiting the arrival of a Member of the Science Committee, the gentleman from Alabama, Mr. Brooks, who is going to introduce our first witness, Dr. Griffin. And while he is on the way, I'm going to proceed and introduce our other two witnesses today.

And our second witness is Colonel Eileen Collins, Retired United States Air Force Colonel and former NASA astronaut and resident of my hometown San Antonio. Colonel Collins was selected by NASA to become an astronaut in 1991. In 1995, she flew the space shuttle as pilot aboard Discovery and then again as pilot in 1997 aboard Atlantis. Colonel Collins became the first woman commander of a U.S. spacecraft with shuttle mission Columbia in 1999. Her final spaceflight mission was as commander of Discovery in 2005, the Return to Flight mission. She has logged more than 6,750 hours in 30 different types of aircraft and more than 870 hours in space as a veteran of four spaceflights.

Colonel Collins received her bachelor's degree in mathematics and economics from Syracuse University, her master of science degree in operations from Stanford University, and a master of arts degree in space systems management from Webster University.

Our final witness is Ms. Cristina Chaplain, Director of Acquisitions and Sourcing Management at the U.S. Government Accountability Office. Ms. Chaplain has a responsibility of GAO assessments of military space acquisitions, NASA, and the Missile Defense Agency. Prior to her current position at GAO, she worked with GAO's Financial Management and Information Technology Team. She has been with GAO for 25 years. Ms. Chaplain received her bachelor's degree from Boston University and her master's degree from Columbia University.

Okay. I'm sure that the gentleman from Alabama will be joining us shortly, but in his absence, I'm going to go on and introduce our first witness today. And that is Dr. Michael Griffin, former NASA Administrator and current Chairman and Chief Executive Officer of Schafer Corporation. Dr. Griffin served as both Chief Engineer and Associate Administrator for Exploration at NASA, as well as Deputy for Technology at the Strategic Defense Initiative Organization. Dr. Griffin is a recipient of numerous honors and awards, including the NASA Exceptional Achievement Medal and the Department Of Defense's distinguished Public Service Medal, the highest award which can be conferred on a nongovernment employee.

Dr. Griffin received his bachelor's degree in physics from Johns Hopkins University and master's degrees in aerospace science from Catholic University, electrical engineering from the University of Southern California, applied physics from Johns Hopkins, civil engineering from George Washington University, and business administration from Loyola College of Maryland. By my count, that's five master's degrees. And his Ph.D. is in aerospace engineering from the University of Maryland.

We welcome you, all three of you, to the hearing today.

And the gentleman from Alabama has arrived, but I still want to recognize him. Even though I just finished introducing Dr. Griffin, I know that the gentleman from Alabama, Mr. Brooks, will

have some comments to make as well. And he is recognized for that purpose.

Mr. BROOKS. I'm sorry, Mr. Chairman. This is my third hearing since 9:30.

From what I understand, you've already introduced——

Chairman SMITH. I just——

Mr. BROOKS. —Dr. Griffin.

Chairman SMITH. I just finished, but I'd like to recognize you to make any additional comments you'd like to make.

Well, Dr. Griffin, thank you for being here. Roll Tide and War Eagle. I'll make it short.

Chairman SMITH. In that case, we will proceed, and, Dr. Griffin, you're welcome to start your testimony.

**TESTIMONY OF DR. MICHAEL GRIFFIN,
FORMER ADMINISTRATOR, NASA**

Mr. GRIFFIN. Thank you, Chairman Smith, Chairman Culberson, Mr. Brooks, for the kind introduction and recognition. I'm—and thanking Ranking Member Johnson and Members of the Committee for appearing here today and allowing me to appear to discuss the future of our nation's space program.

With the inauguration of a new Administration and Congress, we will have both the need and the opportunity to restore American preeminence in space, and after that, to ensure stability in the policy and programs we create. We should begin now, and in that context, it may be of some value to review some of our recent history. Some of that has been summarized by Chairman Culberson in the earlier panel, and I will not repeat it.

I will make the point that, following the loss of Space Shuttle Columbia, the Columbia Accident Investigation Board identified as one of the root causes of that failure the lack of a clearly identifiable long-term strategic plan for NASA. As has been stated, by 2009 that issue had been remedied, and we were executing a powerful and compelling new plan. That plan respected the need to complete existing commitments, the constraints imposed by the geography of the solar system, and the existing state of our technology and operational experience. The plan respected the need of our international partners for a roadmap for human spaceflight beyond the International Space Station, while offering critical challenges to which they could make critical contributions. Finally, being achievable with only incremental real dollar budget growth, it respected realistic budget constraints. It was a good plan.

This strategy received nearly unanimous bipartisan endorsement by successive Congresses, Republican and Democratic, in the NASA Authorization Acts of 2005 and 2008, clearing the path for a period of unimpeded progress. And by early 2009, the shuttle was flying regularly, the ISS was nearing completion, a new crew transportation system was in work, and the first two contracts for commercial cargo delivery to the International Space Station had been signed. Some 14 nations had embraced partnership with the United States to return to the moon and were orienting their own national space policies to that end.

But by early 2010, just a year later, this strategy was in disarray. Human lunar return had been abandoned, as had NASA's

development of a new crew transportation system. There was no plan beyond ISS save for a nebulous commitment to visit an asteroid sometime in the 2020s. Inasmuch as this—such a mission is inherently a one-off exercise with limited opportunities for international involvement, our existing space station partners rightly felt abandoned and potential new partners saw very little merit in working with the United States.

The nations that were eager to participate in space exploration in 2009 still wish to do so today, but a leader is needed for such an endeavor, and for now, the only possible leader is the United States. If we do not choose to engage, then eventually other nations will, and we're unlikely to be pleased with that result. This is not a future that the United States should allow to come to pass.

Our space policy is bankrupt. While I certainly support the stability for NASA that is the topic of this hearing today, I would not want that desire to prevent us from correcting the problems that have been created over the last seven years. To quote my friend and colleague Jim Albaugh, the former Boeing commercial aircraft CEO, the current Administration's plan for space offers "no dream, no vision, no plan, no budget, and no remorse." We can fix this and we must.

Thank you. I would be happy to answer any of your questions.
[The prepared statement of Mr. Griffin follows:]

Witness Statement

Hearing on "The Space Leadership Preservation Act and the Need for Stability at NASA"

U.S. House of Representatives
Committee on Science, Space and Technology

Rayburn House Office Building
Room 2318

Michael D. Griffin

25 February 2016

Chairman Smith, Ranking Member Johnson, and Members of the Committee: I am honored to appear before you today to discuss the future of our nation's space program. In my opinion, the timing and subject of this hearing are perfectly chosen. Within the year we will have a new administration in office and a new Congress in power, and one of the key questions confronting those elected representatives will be to determine how we can best go about restoring American preeminence in space. And, after getting our space program back on track, there will be no more important task than that of ensuring its stability. The last six years have provided an object lesson as to the consequences of failure to do so. In that regard, it may be of value to this committee, and consistent with the topic of this hearing, to review some of that history.

As the year 2009 opened, we had a plan for our nation's space program, a plan of generational scope for what it was that NASA was expected to do. That plan had been hammered out during the long and difficult period following the loss of Space Shuttle *Columbia*, the examination of the root causes of that loss by Adm. Hal Gehman's Columbia Accident Investigation Board (CAIB), and with the benefit of advice and counsel from all segments of the space community. I myself was invited to testify before both House and Senate on various aspects of space policy and programs some four times in 2003-04. The same was true of many, many others in this time of challenging, thoughtful deliberation concerning our future in space. No reasonable space policy alternative was left unexamined by the Executive and Legislative Branches prior to determining of what would be expected of NASA in the post-*Columbia* era.

The key elements of that plan were easily summarized. NASA and its contractor workforce would return the Space Shuttle to flight, incorporating the technical and programmatic corrections recommended by the CAIB. In keeping with our domestic and international commitments, the Shuttle would be used to complete the assembly of the International Space Station (ISS), after which it would be retired. During and following the fly-out of the Space Shuttle, and in accordance with a key CAIB recommendation, a new human space transportation system would be developed with a primary focus on safety and reliability. This system was to be completed not later than 2014, and then used to ferry astronauts from our

own and international partner nations to and from the ISS. Additionally, the strategy called for new commercial sector programs to foster competition and innovation for cargo delivery to the ISS throughout its remaining lifetime. Looking beyond the completion of the ISS, this new crew transportation system would also support the human return to the Moon by 2020, and the subsequent establishment of a permanent lunar outpost by the U.S. and its international partners. Finally, these developments were to be carried out in such a way as to enable later voyages to Mars.

This was a powerful and compelling strategic plan for our nation's future in space, not least because it could be expressed so concisely. It respected the need to complete existing commitments, even when doing so was hard – very hard. It respected the constraints imposed by both the geography of the Solar System and the existing state of our technology and space operations experience. It respected the needs of our international partners to have a near-term roadmap for human space activity beyond the completion of the ISS, while yet featuring arenas in which they could make critical contributions to critical challenges. And finally, it respected budget constraints, being achievable with incremental real-dollar budget growth beyond then-current levels.

The intrinsic merit of this plan was recognized by two successive Congresses, one controlled by Republicans and the other by Democrats, in the NASA Authorizations Acts of 2005 and 2008, respectively – yet another example of the historically strong bipartisan support that the Congress has always shown for our space program. And by early 2009, we had painfully but thoroughly recovered from the loss of *Columbia* and were well established on the way forward. The Shuttle had been returned to flight, the ISS was nearing completion, the elements of a new crew transportation system were in development, and the first two contracts for commercial cargo delivery to the ISS had been signed. Looking to the future, some fourteen nations had firmly embraced a plan to partner with the United States for a human return to the Moon, and were orienting their own national space plans and policies to that end.

But by early 2010, barely a year later, this carefully hewn strategy was in disarray. Human lunar return had been abandoned as a goal toward which we and our partners would work, as was the development by NASA of a crew transportation system to replace the Space Shuttle. Our existing commitments to our partners to supply crew transportation to ISS, in exchange for the laboratory modules and other ISS infrastructure that they had built, would be met for the foreseeable future by telling them to buy rides on the Russian *Soyuz*. Beyond the ISS, there was no plan save for a nebulous commitment to visit an asteroid sometime in the 2020s. Inasmuch as such a mission was inherently a one-off exercise offering little or no possibility for international involvement, our existing ISS partners rightly felt abandoned, and potential new partners saw little merit in aligning their programs with those of the United States.

In this context, we must understand that if U.S. leadership in space is important to our nation, then it is necessary to have goals which potential partners might wish to embrace. A one-time visit to an asteroid or, worse, visits to a boulder which has been robotically towed into cislunar space from an asteroid, a mission not adequately supported by the budget allocated to it, a

mission not even endorsed by the scientific community – this does not constitute such a goal. Contrariwise, returning to the Moon did, and does. The same nations that were eager to join us in that enterprise in 2009 still wish to do so; they are simply waiting for us to lead.

At this point I will note explicitly that I am *not* advocating a return to the Constellation architecture as it existed during my tenure as Administrator. Constellation was a particular engineering instantiation of an architecture that was itself designed to address the requirements of the space policy that was proposed by the president and codified into law by the Congress between 2005 and 2010. While I believed then and believe now that this was the best space policy we had seen since the early 1960s, the Constellation design itself was heavily dependent upon the smooth transition of both hardware and personnel from the Space Shuttle program. While the goal of effecting that transition from Shuttle to a follow-on system was consistently and explicitly required by the Congress, this direction was in the end willfully ignored by the present administration. So that opportunity was botched, and is gone forever. It cannot be recovered. What is needed today is, first, to reestablish a sensible space policy, and then consider how an efficient architecture to implement that policy might be designed.

I remind us of this history because of its relevance to the topic of the present hearing: ensuring the stability of the U.S. space program. It is emphatically not my view that we can never change our policies in space, or indeed in any other arena. Such a view would be disastrous. We must be prepared to alter course when circumstances and events demand. Indeed, the changes to our national space policy that were developed and enacted in 2003-05 were the most significant since President Nixon's cancellation of the Apollo program. But – and this is the key point – they were deliberated and advocated and debated in the open, over a sufficient period of time to allow all views to be heard, and in a multitude of venues, including the one in which we find ourselves today, this very room.

In contrast, the space policy changes wrought in 2010 were not proffered to or discussed with Congress, our international partners, the various stakeholders in the domestic space community, or even senior officials at NASA. They were not even represented as changes to core policy, but rather were developed in secret and put forth only as part of the President's Budget Request in February of that year. Especially telling was the fact that even Congressional Democrats were not involved; this was not a partisan decision, but a White House decision.

A national space program, as indeed with most Federal endeavors, is a ponderous thing. It is a difficult thing to change suddenly and, I would argue, should be difficult to change. The highly visible adverse consequences of the administration's abrupt departure in 2010 from an established and strongly bipartisan space policy, twice approved by Congress, should, I believe, give us pause for thought. We do not need, and would not benefit from, another overly abrupt change. It would not help our industry, it wouldn't help our international partners, and it would not allow the consensus to be developed that is necessary for a space program whose goals must be sustained over generational spans. But with that said, we are not now on the right path, and over the coming year or so we need to think carefully about what the proper

course for the future might be, and how best to get back on that course while creating the least possible collateral damage.

What might the “right path” look like? I have been clear in the past and hope to be clear now – to me the most logical step beyond the ISS is an international partnership, led by the United States, to return to the Moon, this time to stay. In the course of so doing we will learn what is needed to go beyond, to go to Mars. And if, as I have long suspected, the Moon turns out to be quite an interesting and useful destination in its own right, well then, so much the better.

But whatever path we choose, we must have clearly stated and executable objectives that are of interest to a broad array of domestic and international stakeholders and are supported with real budgets and real programs. Today’s budgets and programs might cause the cynics among us to conclude that while Mars is indeed our goal, it always will be.

Space is the human frontier, as important to our future as were the frontiers of land, sea, and air that we faced in the past. We are just beginning to understand how we might explore, and exploit, that frontier. The consequences of getting it right or wrong are not immediate, but they are enormous when viewed in their proper historical context, involving as they do many questions of profound significance to our society.

We must ask ourselves not only what is our next destination but, more broadly, what is the nature and value of a human future in space? What directions will human society take as a result of opening the space frontier? Closer to home, how will the lives and security of Americans be directly affected by a retreat from space, or by our continuing dependence on others to get there? What social and cultural values will evolve and prevail, and how will we influence these developments? How is our stature as a world power affected if we are not present on the human frontier, when others are? What is the effect on our national security, if we are no longer regarded as the preeminent world space power? Can our nation remain open, vital, relevant, competitive and forward-looking in science, technology, culture, and commerce, if it turns back from the frontier of its time?

These are existential questions for our society, with profound security and economic implications; they deserve a proper debate and continuing oversight by our nation’s deliberative bodies. Our people deserve a stable commitment by policy makers to the answers that emerge. If we are not able, or do not choose, to engage these issues, then other nations and societies will, and we are unlikely to be pleased with the result.

These issues are not presently part of our national space policy discussion. We are not, in fact, even engaged in such a discussion. To quote my friend and colleague Jim Albaugh, the now-retired CEO of Boeing Commercial Aircraft, the current administration’s view of our nation’s future in space offers “no dream, no vision, no plan, no budget, and no remorse.” We must remedy this matter with all deliberate speed.

Thank you. I would be happy to answer any questions you may have.

Michael D. Griffin

Michael Griffin is the Chairman and Chief Executive Officer of Schafer Corporation, a leading provider of scientific, engineering and technical services and products in the national security sector. He was previously King-McDonald Eminent Scholar and Professor of Mechanical and Aerospace Engineering at the University of Alabama in Huntsville, was the Administrator of NASA from 2005-09, and prior to that was the Space Department Head at the Johns Hopkins University Applied Physics Laboratory. He has also held numerous executive positions with industry, including President and Chief Operating Officer of In-Q-Tel, Chief Executive Officer of Magellan Systems, General Manager of Orbital Science Corporation's Space Systems Group, and Executive Vice President and Chief Technical Officer at Orbital.

Mike's earlier career includes service as both Chief Engineer and Associate Administrator for Exploration at NASA, and as the Deputy for Technology at the Strategic Defense Initiative Organization. Prior to joining SDIO in an executive capacity, he played a key role in conceiving and directing several "first of a kind" space tests in support of strategic defense research, development, and flight testing. These included the first space-to-space intercept of a ballistic missile in powered flight, the first broad-spectrum spaceborne reconnaissance of targets and decoys in midcourse flight, and the first space-to-ground reconnaissance of ballistic missiles during the boost phase. He also played a leading role in other space missions in earlier work at the JHU Applied Physics Laboratory, NASA's Jet Propulsion Laboratory, and the Computer Science Corporation.

Mike was an adjunct professor for thirteen years at the University of Maryland, the Johns Hopkins University, and George Washington University, offering courses in spacecraft design, applied mathematics, guidance and navigation, compressible flow, computational fluid dynamics, spacecraft attitude control, estimation theory, astrodynamics, mechanics of materials, and introductory aerospace engineering. He is a Registered Professional Engineer in Maryland and California, and is the lead author of over two dozen technical papers and the textbook *Space Vehicle Design*.

Griffin is a member of the National Academy of Engineering and the International Academy of Astronautics, an Honorary Fellow and former President of the American Institute of Aeronautics and Astronautics, a Fellow of the American Astronautical Society, and a Senior Member of the Institute of Electrical and Electronic Engineers. He is the recipient of numerous honors and awards, including the NASA Exceptional Achievement Medal, the AIAA Space Systems Medal and Goddard Astronautics Award, the National Space Club's Goddard Trophy, the Rotary National Award for Space Achievement, the Missile Defense Agency's Ronald Reagan Award, and the Department of Defense Distinguished Public Service Medal, the highest award which can be conferred on a non-government employee.

Mike obtained his B.A. in Physics from the Johns Hopkins University, which he attended as the winner of a Maryland Senatorial Scholarship. He holds Master's degrees in Aerospace Science from Catholic University, Electrical Engineering from the University of Southern California, Applied Physics from Johns Hopkins, Civil Engineering from George Washington University, and Business Administration from Loyola College of Maryland. He received his Ph.D. in Aerospace Engineering from the University of Maryland, and has been recognized with honorary doctoral degrees from Florida Southern College and the University of Notre Dame.

Mike was born in 1949 in Aberdeen, Maryland. His hobbies include golf, flying, amateur radio, skiing, and scuba diving. He is a Certified Flight Instructor with instrument and multiengine ratings, and holds an Extra Class radio amateur license.

Chairman SMITH. Thank you, Dr. Griffin.
Colonel Collins.

**TESTIMONY OF COLONEL EILEEN COLLINS, USAF (RET.);
COMMANDER, STS-93 AND 114; AND PILOT, STS-63 AND 94;
AND FORMER CHAIR, SUBCOMMITTEE ON SPACE
OPERATIONS,
NASA ADVISORY COUNCIL**

Ms. COLLINS. Thank you, Chairman Smith and Ranking Member Johnson and Committee Members. It is a pleasure for me to be here today to talk about the future of our great country and to share my perspective as a former space shuttle commander. I have a passion for exploration, and I'm firmly committed to the future successes of our country's space program.

A few words about my background, I'm a former Air Force test pilot, a graduate of the Air Force Test Pilot School, and a veteran of four spaceflights. I served for five years on the NASA Advisory Council from 2007 to 2011. I currently serve on the National Academy of Sciences' Aerospace Science and Engineering Board, and although I serve on this and many other boards and advisory panels, I want to say that I'm here today representing myself and not any of these other panels.

So in my opening comments I have three general points. The first one is I want to thank you for asking the opinion of the operators of our space systems or the guys in the trenches so to speak. I hope I can give you an operational perspective from the astronaut's point of view.

Secondly, I can't emphasize enough the love that Americans have for our space program. As a speaker and as an advisor, I routinely meet people from all around the United States. They are inspired by human spaceflight and they are very excited about scientific discoveries. They see the space program as a bright future, where we can imagine possibilities both human and technical.

And frankly, the brand of NASA is easy to love. For example, my story began in 4th grade when I read a magazine article about the Gemini astronauts. Since then, I've wanted to fly in space and be part of this great adventure. It led me to study of mathematics and a career in flying.

Today, I see people of all ages light up when the subject of space travel is discussed. In my opinion, the history of American exploration is right up there with baseball, apple pie, and the Fourth of July. And I might add that the recent announcement for new astronauts brought a record number of applicants, 18,300 applicants, which is more than twice as many as the previous record.

Now, my third point concerns the purpose and stability of the human spaceflight program. Obviously, the success of any decades-long program is related to the long-term commitment from the top. So first, a mission is defined. Next, a strategy is set. And then, an operational plan is written. Now, that operational plan includes a test plan, and a test plan includes a build-up approach. This is one of the fundamentals that we learn when we go—and that we teach when we go through the test pilot schools.

As we run a test program, occasionally, technical changes will need to be made because we learn as we go. Sometimes, we make

mistakes when we do things for the first time. But necessary technical changes will not affect the originally defined mission. That must stay stable so that the team members can stay focused on the mission.

I understand the long-range vision for U.S. human—for the U.S. human spaceflight program is landing a human on Mars. I support that mission. And I sincerely hope that that first person is an American. We can do it, and frankly, we can afford it. Those who say we can't are just putting their priorities elsewhere.

When asked about how to best prepare for a successful Mars mission, as a crewmember, I certainly would like to see the hardware tested on the moon's surface first. This is part of a test plan's build-up approach. Policy leaders are asking astronauts to risk their lives on space journeys, and it is our experience that testing in similar environments like the moon will minimize risk.

When the Constellation program was cancelled in 2010, some people said, "why go back to the moon? We've already been there." Imagine the year 1806, when Lewis and Clark returned from their 2-1/2 year journey of exploring the western continent. They and their team members are declared national heroes. But then no one else goes back because we had already been there. Of course, this is almost inconceivable. It would diminish the entire reason for going in the first place.

I was a member of the NASA Advisory Council when Constellation was cancelled. I was shocked, as were my colleagues, first, because it was so unexpected, and second, because the timing, so close to the end of the space shuttle program, left NASA with no options.

The legislation that we're discussing here today has ideas that will certainly address this problem. I'm not wedded to any specific proposal myself, but the problem does need to be addressed, especially given the billions of dollars wasted as a result and the lost time and motivations of engineers and astronauts.

I believe program cancellation decisions that are made by bureaucracies, behind closed doors, without input by the people, are divisive, damaging, cowardly, and many times more expensive in the long run. As a shuttle commander, I would never make a huge decision without input from all the experts, even the ones I do not agree with.

So what will keep us from having surprises like this set us back years? A continuity of purpose over many years and political administrations. I know there are ways to do this through policy, organizational structure, and strong leadership. And finally, strategic stability will give the teams efficiency and a focus that we saw in the Apollo program. Apollo happened by the end of the decade because people knew exactly what the mission was and when it should happen. They believed in it. And of course it was properly funded. There was not much division over what the mission was, and NASA was given the responsibility to figure out how to do it, and the result was dedication, passion, and success. And I know we can do this again. Thank you.

[The prepared statement of Ms. Collins follows:]

Eileen Collins' Witness Statement

Hearing on "The Space Leadership Preservation Act and the Need for Stability at NASA"

U.S. House of Representatives

Committee on Science, Space, and Technology

Feb 25, 2016

Chairman Smith, Ranking Member Johnson, and Committee Members: it's a pleasure to be here today, with an opportunity to speak about the future of our great country, and to share my perspective as a former space shuttle commander. I have a passion for exploration, and am firmly committed to the success of our country's space adventures.

A few words about my background: I am a former Air Force pilot, a graduate of the Air Force Test Pilot School, and a veteran of four space flights. I served five years on the NASA Advisory Council, from 2007-2011, and currently serve on the National Academy of Sciences' Aerospace Science and Engineering Board. Although I serve on this and several other advisory boards, I am here today representing myself only and not any organization.

In my opening comments, I have three general points:

First, I thank you for asking the opinion of the "operators" of our space systems (or "the guys in the trenches", so to speak). I hope I can give you an operational perspective from the astronaut's point of view.

Second, I cannot emphasize enough, the love Americans have for their space program. As a speaker and advisor, I routinely meet people all around the United States. They are inspired by human spaceflight and excited about scientific discoveries. They see the space program as a bright future, where we can imagine possibilities both human and technical.

Frankly, the "brand" of NASA is easy to love.

For example, my story began in 4th grade, where I read a magazine article about the Gemini astronauts. Since then I have wanted to fly in space and be part of this great adventure. It led me to the study of mathematics and a flying career. Today, I see people of all ages "light up" when the subject of space travel is discussed. In my opinion, the history of American exploration is right up there with baseball, apple pie, and the fourth of July.

My Third point concerns the purpose and stability in the human spaceflight program. Obviously, the success of any decades-long program is related to the long term commitment from the top. First, the mission is defined. Next, the strategy is set. Then, the operational plan is written;

which includes a test plan. A test plan includes a “build up” approach. As we run a test program, occasionally technical changes will need to be made because we learn as we go. Sometimes we make mistakes when we do things for the first time. But necessary technical changes will not affect the originally defined mission. That must stay stable so the team members can stay focused on the outcome.

My idea of a successful program is: cut the fat, integrity always, get the smartest people, and remind them every day that leadership is committed to supporting the mission. There’s more, but that’s the meat of it.

I understand the long range vision for the US human spaceflight program is landing a human on Mars. I support that mission. I hope that first person is an American. We can do it. And frankly, we can afford it. Those who say we can’t are just putting their priorities elsewhere.

When asked about how best to prepare for a successful Mars mission, as a crewmember, I certainly would like to see the hardware tested on the moon’s surface first. This is part of a test plan’s “build up approach”. Policy leaders are asking astronauts to risk their lives on space journeys, and it is our experience that testing in similar environments will minimize risk.

When the Constellation Program was cancelled in 2010, some people said: “Why go back to the Moon? We’ve already been there!” Imagine the year 1806, when Meriwether Lewis and William Clark returned from their 2 ½ year journey of exploring the western continent. They and their team are declared national heroes. But then no one else goes back because “we had already been there”. This is almost inconceivable.... It would diminish the entire reason for going in the first place!

I was a member of the NASA Advisory Council when Constellation was cancelled. I was shocked as were my colleagues, first because it was SO unexpected, and second because of the timing so close to the end of the shuttle program, which left NASA with no options. The legislation we are discussing today: “*Space Leadership Preservation Act of 2015* (H.R. 2093)” has ideas that will certainly address this problem. I am not wedded to any specific proposal but this problem needs to be addressed, especially given the billions of dollars wasted as a result and the lost time and motivations of engineers and astronauts.

I believe program cancellation decisions that are made by bureaucracies, behind closed doors, and without input by the people, are divisive, damaging, cowardly, and many times more expensive in the long run. As a shuttle commander, I would never make a huge decision without input from all the experts, even the ones I do not agree with. So what will keep us from having surprises like this that set us back years? Answer: A continuity of purpose over many years, over political administrations, and over normal changes in leadership throughout the chain of command. I know there must be ways to do this through policy, organizational structure, and strong leadership.

Strategic stability will give the team efficiencies and a focus that we saw in the Apollo program. Apollo happened by “the end of the decade” because people knew exactly what the mission was and when it should happen. They believed in it. And of course it was properly funded. There was not much division over what the mission was: and NASA was given the responsibility to figure out how to do it. The result was dedication, passion, and success. I know we can do this again.

Eileen M. Collins is a former astronaut and a retired U.S. Air Force colonel. She retired from the Air Force in Jan 2005 and from NASA in May 2006 after a 28-year distinguished career. A former military instructor and test pilot, Collins was the first woman pilot and first woman commander of a space shuttle.

After graduation from Elmira Free Academy in 1974, she attended Corning Community College, earning an associate degree in mathematics/science in 1976. She then received a bachelor's degree in mathematics and economics from Syracuse University in 1978, where she was an Air Force ROTC Distinguished Graduate. She has earned a master of science degree in operations research from Stanford University in 1986, and a master of arts degree in space systems management from Webster University in 1989.

Collins graduated in 1979 from Air Force Undergraduate Pilot Training at Vance Air Force Base, Oklahoma, where she was a T-38 instructor pilot until 1982. From 1983 to 1985, she was a C-141 aircraft commander and instructor pilot at Travis Air Force Base, California, and spent the following year as a student with the Air Force Institute of Technology. From 1986 to 1989, Collins was assigned to the U.S. Air Force Academy in Colorado, where she was an assistant professor in mathematics and a T-41 instructor pilot.

Collins graduated from the Air Force Test Pilot School at Edwards Air Force Base, California, in 1990. She was selected by NASA and became an astronaut in July 1991. After tours at Kennedy Space Center (shuttle launch and landing) and Johnson Space Center (shuttle engineer and capsule communicator), she flew the space shuttle as pilot in 1995 aboard *Discovery*. She was also the pilot for *Atlantis* in 1997, where her crew docked with the Russian Space Station MIR. Collins became the first woman commander of a U.S. spacecraft with shuttle mission *Columbia* in 1999, the deployment of the Chandra X-Ray Observatory. Her final space flight was as commander of *Discovery* in 2005, the "*Return to Flight Mission*" after the tragic loss of *Columbia*. She has logged more than 6,751 hours in 30 different types of aircraft and more than 872 hours in space as a veteran of four space flights.

Collins currently serves on several boards and advisory panels, is a professional speaker and an aerospace consultant. She is married with two children.

Collins is also a member of the Air Force Association, Order of Daedalians, Women Military Aviators, Women in Aviation International, U.S. Space Foundation, the American Institute of Aeronautics and Astronautics, and the Ninety-Nines.

Chairman SMITH. Thank you, Colonel Collins.
And, Ms. Chaplain.

**STATEMENT OF MS. CRISTINA CHAPLAIN, DIRECTOR,
ACQUISITIONS AND SOURCING MANAGEMENT,
GOVERNMENT ACCOUNTABILITY OFFICE (GAO)**

Ms. CHAPLAIN. Chairman Smith, Ranking Member Johnson, and Members of the Committee, thank you for inviting me to discuss the Space Leadership Preservation Act. You've heard the policy and strategic perspective, as well as the operational perspective, and I'm here today to discuss the acquisition management perspective.

As you know, NASA's acquisition management has been on GAO's high-risk list for more than two decades because of persistent cost growth and schedule slippage. In recent years, however, NASA has made progress in reducing this risk. Specifically, in 2012, shortly after NASA re-baselined its largest project, the James Webb telescope, development cost growth averaged about 46 percent. This year, we plan to report that it is at 17 percent. And when James Webb is excluded, cost growth is just 1.3 percent, though that number is affected by the addition of Space Launch System and Orion to the portfolio.

NASA has made positive changes in the past five years that have helped contribute to the improved performance of its projects. These include better cost and schedule estimating, use of management reserves, and program monitoring. Moreover, many projects are able to demonstrate that they have closed gaps in knowledge about technology and design at key junctures in their development process.

This does not mean NASA's acquisition problems are solved. Several projects in the portfolio are experiencing significant problems that are not just the result of inherent technical risk. Programs still struggle with underestimating complexity and managing and overseeing contractors. Moreover, the most complex and costly development efforts, the human spaceflight projects and James Webb, are entering their most risky phases of development. Before we can take NASA off our high-risk list, we need to see how these projects perform in times when they are most tested.

Further, while initial estimates are more realistic, we are finding larger projects do not plan to update their estimates on a regular basis and that estimates are not always well supported by well-defined schedules. The baselines for human spaceflight projects also provide little visibility into long-term planning and costs.

Today, this Committee is discussing the concern that NASA needs more stability in order to truly thrive. That is what the Space Leadership Preservation Act is focused on. The concept of stability is an important one for NASA since projects require heavy investments both in terms of time and money, and they require the cooperation and support from a variety of communities.

We have not assessed the extent to which the act can insulate NASA from instability, but I do have a couple observations. First, if NASA were to implement a Board of Directors, that board must be willing to hold program managers accountable, as well as leadership, by cancelling or restructuring programs that do not perform well. I recognize there is a frustration that shuttle successor pro-

grams never seem to make it very far, and it's clear that these programs are impacted by politics. On the other hand, when projects prove to be too ambitious or poorly managed, not cancelling them or not changing them can be damaging to the rest of NASA's portfolio.

Second, the act emphasizes the use of longer-term or multiyear contracts. Multiyear contracts can potentially save money and improve the industrial base by permitting more efficient use of the contractor's resources. It's important to keep in mind, however, that they are generally used for more production items and low-risk technology. Not too many NASA projects fit this description. Multiyear contracts can also reduce Congress's flexibility, as well as the agency's flexibility in making changes to programs and budgets, so the decision to use them needs to be carefully considered.

Finally, as you assess these measures, I would like to emphasize that our examinations of complex acquisitions across the government continually show that acquisition success hinges on 1) having robust long-term plans to guide programs; 2) having a sound business case when starting a program; 3) providing the right support and oversight throughout the life of the program.

We look forward to continuing to work with NASA and the Committee in instituting these improvements.

Thank you. I'm happy to answer any questions you have.

[The prepared statement of Ms. Chaplain follows:]



United States Government Accountability Office

Testimony
Before the Committee on Science,
Space, and Technology, House of
Representatives

For Release on Delivery
Expected at 10:00 a.m. ET
Thursday, February 25, 2016

NASA

**Preliminary Observations
on Major Acquisition
Projects and Management
Challenges**

Statement of Cristina T. Chaplain, Director,
Acquisition and Sourcing Management

GAO Highlights

Highlights of GAO-16-461T, a testimony before the Committee on Science, Space, and Technology, House of Representatives

Why GAO Did This Study

The proposed Space Leadership Preservation Act of 2015, which includes provisions related to NASA's leadership structure, budget development, and contracting authorities, would affect the way NASA develops its vision for space exploration and executes the projects that implement it. It could also have implications for NASA's acquisition management, which is an area on GAO's High Risk list. In March 2015, GAO found that projects continued a general positive trend of limiting cost and schedule growth, maturing technologies, and stabilizing designs, but that NASA faced several challenges that could affect its ability to effectively manage its portfolio.

This statement provides our preliminary observations on (1) the cost and schedule performance of NASA's portfolio of major projects and the implementation of product development best practices on these projects and (2) management challenges. This statement also provides observations on the proposed legislation. This statement is based on ongoing work to be published in March 2016 and GAO's February 2015 High Risk Update, as well as GAO's extensive prior body of work on NASA's major acquisitions.

What GAO Recommends

GAO is not making any new recommendations in this statement, but has made recommendations in prior related reports, which NASA has not yet fully addressed.

View GAO-16-461T. For more information, contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov.

February 2016

NASA

Preliminary Observations on Major Acquisition Projects and Management Challenges

What GAO Found

GAO's ongoing work indicates that the National Aeronautics and Space Administration (NASA) has made progress over the past 5 years in a number of key acquisition management areas, but it faces significant risks in some of its major projects. On the positive side, the cost and schedule performance of NASA's portfolio of major projects in development has improved and most current projects are adhering to their committed cost and schedule baselines. In addition, NASA has maintained recent improvements in the implementation of key product development best practices, which can help reduce risk in projects. Although NASA's overall performance has improved, GAO's preliminary results show that NASA has rebaselined a major project for each year 8 out of the last 9 years, which means the projects experienced significant cost or schedule growth. This often occurs as projects prepare to begin system assembly, integration, and test; nine projects will be in that phase of development in 2016, including the Orion Multi-Purpose Crew Vehicle (Orion) and Space Launch System, which are human spaceflight programs with significant development risks.

As NASA continues its efforts to reduce acquisition risk, GAO's ongoing and prior work highlights three areas of management challenges that, if addressed, will help the agency appropriately direct future investments:

- **Implementing Management Tools.** NASA has continued to implement improved project management tools to manage acquisition risks, but these efforts have not always been consistent with best practices in areas such as cost estimating or fully addressed GAO's prior recommendations. For example, NASA has made progress rolling out earned value management (EVM)—a key project management tool—at its centers but has not implemented formal EVM surveillance, which is considered a best practice by both NASA and GAO.
- **Demonstrating Sustained Cost and Schedule Performance.** A key management challenge that NASA faces is whether the improvement in the cost and schedule performance GAO has seen in the agency's overall portfolio of major projects can be translated to large, recently baselined projects that have been added to the portfolio. This includes its human spaceflight projects, which are at critical points of implementation.
- **Long-Term Planning and Stability.** NASA has established cost and schedule baselines for Space Launch System, Orion, and Exploration Ground Systems—a program that is developing systems and infrastructure to support assembly, test, and launch of the Space Launch System and Orion—but the baselines provide little visibility into long-term planning and costs. NASA recently issued a strategy for its journey to Mars, but the document does not provide details on future exploration missions making it difficult to understand NASA's vision for what type and how many missions it will take to get to Mars.

The proposed Space Leadership Preservation Act of 2015 is aimed, in part, at achieving greater stability at NASA. From an acquisition perspective, GAO's prior work indicates that one of the most important factors for achieving stability is having a sound business case that balances program requirements and resources, such as technology, funding, and time.

United States Government Accountability Office

Chairman Smith, Ranking Member Johnson, and Members of the Committee:

I am pleased to be here today to discuss the National Aeronautics and Space Administration's (NASA) management of its major acquisition projects and the legislation that is being considered by this committee. NASA's major projects are the key enablers for the agency to achieve its vision and its mission. They include the Space Launch System and Orion Multi-Purpose Crew Vehicle (Orion), which are the centerpieces of NASA's human exploration plans; Mars 2020 and Europa, which will further our understanding of the habitability of other planets; and the Ice, Cloud, and Land Elevation Satellite-2, which will provide better data on changes in the Earth. In fiscal year 2016, NASA plans to spend over \$6 billion on its 18 major projects, each with a life-cycle cost of over \$250 million. In total, these projects represent an expected investment of almost \$54 billion with more expected for the human spaceflight efforts over the longer run.

The proposed Space Leadership Preservation Act of 2015, which includes provisions related to NASA's leadership structure, budget development, and contracting authorities, would affect the way NASA develops its vision for space exploration and executes the projects that implement it. It could also have implications for acquisition management. Acquisition management has been a long-standing challenge at NASA, although we have reported on improvements the agency has made in recent years.¹ We first designated NASA's acquisition management as a high-risk area in 1990 in view of NASA's history of persistent cost growth and schedule slippage in the majority of its major projects. Our work has identified a number of causal factors related to these issues, including poor cost estimating and underestimation of risks associated with the development of its major systems, as well as a set of best practices that can help agencies manage development risks. NASA leadership has made concerted efforts to address these causal factors, but our work has found that more can be done, particularly for NASA's largest and most critical projects.

¹For example, see GAO, *NASA: Assessments of Selected Large-Scale Projects*, GAO-15-320SP (Washington, D.C.: Mar. 24, 2015).

My statement today provides our preliminary observations on (1) the cost and schedule performance of NASA's current portfolio of major projects and the implementation of product development best practices on these projects and (2) NASA's management challenges. I will also offer a few observations on the proposed legislation based on our work on acquisition management.

My statement today is based on our ongoing work for this committee and others on the status of NASA's major projects, as well as our February 2015 High Risk Update and other past reports.² To assess the cost and schedule performance, technology maturity, and design stability of NASA's major projects, we collected information on these areas from projects using a data collection instrument, analyzed projects' monthly status reports, interviewed NASA project and headquarters officials, and reviewed project documentation. There are 18 major projects in total, but the information available depends on where a project is in its life cycle. For the 12 projects in the implementation phase we compared current cost and schedule estimates to their original cost and schedule baselines, identified the number of technologies being developed and assessed their technology maturity against GAO-identified best practices and NASA policy, and compared the number of releasable design drawings at the critical design review against GAO-identified best practices and analyzed subsequent design drawings changes.³ We also reviewed historical data on cost and schedule performance, technology maturity, and design stability for major projects from our prior reports and compared it to the

²GAO, *James Webb Space Telescope: Project on Track but May Benefit from Improved Contractor Data to Better Understand Costs*, GAO-16-112 (Washington, D.C.: Dec. 17, 2015), *Space Launch System: Management Tools Should Better Track Cost and Schedule Commitments to Adequately Monitor Increasing Risk*, GAO-15-596 (Washington, D.C.: Jul. 16, 2015), GAO-15-320SP, *High-Risk Series: An Update*, GAO-15-290 (Washington, D.C.: Feb. 11, 2015), *James Webb Space Telescope: Actions Needed to Improve Cost Estimates and Oversight of Test and Integration*, GAO-13-4 (Washington, D.C.: Dec. 3, 2012), *NASA: Earned Value Management Implementation across Major Spaceflight Projects Is Uneven*, GAO-13-22 (Washington, D.C.: Nov. 19, 2012) and *NASA: Long-Term Commitment to and Investment in Space Exploration Program Requires More Knowledge*, GAO-06-817R (Washington, D.C.: Jul 17, 2006).

³Five projects were in an early stage of development called formulation when there are still unknowns about requirements, technology, and design. For those projects, we included preliminary cost ranges and schedule estimates. The Commercial Crew Program has a tailored project life-cycle and project management requirements. As a result, it was excluded from our cost and schedule performance, technology maturity, and design stability analyses.

performance of NASA's current portfolio of major projects. To assess major management challenges, we examined NASA's efforts to address issues identified in our prior work, such as the quality of the cost and schedule risk analyses and earned value management implementation issues, and our February 2015 High Risk Update.⁴

We are conducting the work on which this statement is based in accordance with generally accepted government auditing standards. We plan to issue a final report on our annual assessments of NASA's major projects in late March 2016. NASA provided us technical comments on the major projects we reviewed and other information that is included in this statement.

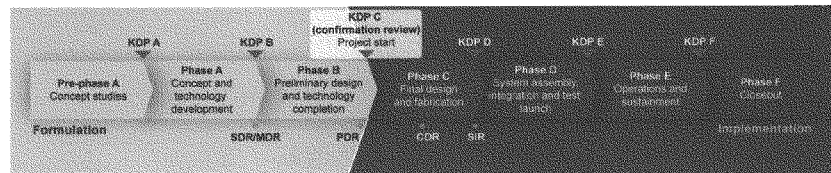
Background

NASA's mission is to drive advances in science, technology, aeronautics, and space exploration and contribute to education, innovation, our country's economic vitality, and the stewardship of the Earth. To accomplish this mission, NASA establishes programs and projects that rely on complex instruments and spacecraft. NASA's portfolio of major projects ranges from space satellites equipped with advanced sensors to study the Earth to a spacecraft which plans to return a sample from an asteroid to a telescope intended to explore the universe to spacecraft to transport humans and cargo to and beyond low-Earth orbit. Some of NASA's projects are expected to incorporate new and sophisticated technologies that must operate in harsh, distant environments.

The life cycle for NASA space flight projects consists of two phases—formulation, which takes a project from concept to preliminary design, and implementation, which includes building, launching, and operating the system, among other activities. NASA further divides formulation and implementation into phase A through phase F. Major projects must get approval from senior NASA officials at key decision points before they can enter each new phase. Figure 1 depicts NASA's life cycle for space flight projects.

⁴GAO-15-596, GAO-15-290, GAO-13-4, and GAO-13-22.

Figure 1: NASA's Life Cycle for Space Flight Projects

**Management decision reviews**

▼ KDP = key decision point

Technical reviews

- 1. SDR/MDR = system definition review/mission definition review
- 2. PDR = preliminary design review
- 3. CDR = critical design review
- 4. SIR = system integration review

Source: NASA data and GAO analysis. | GAO-16-461T

Formulation culminates in a review at key decision point C, known as project confirmation, where cost and schedule baselines are established and documented in a decision memorandum. To inform those baselines, each project with a life-cycle cost estimated to be greater than \$250 million must also develop a joint cost and schedule confidence level (JCL). The JCL initiative, adopted in January 2009, is a point-in-time estimate that, among other things, includes all cost and schedule elements, incorporates and quantifies known risks, assesses the impacts of cost and schedule to date, and addresses available annual resources. NASA policy requires that projects be baselined and budgeted at the 70 percent confidence level.⁵

Our ongoing work on NASA's major projects includes assessments of 18 major NASA projects. Figure 2 includes more information on the projects.

⁵NASA Procedural Requirements 7120.5E NASA Space Flight Program and Project Management Requirements para 2.4.4 (Aug. 14, 2012) (hereinafter cited as NPR 7120.5E (Aug. 14, 2012)). The decision authority for a project can approve it to move forward at less than the 70 percent confidence level. That decision must be justified and documented.

Figure 2: Major NASA Projects That Will Be Included in GAO's 2016 Assessment

	Acronym	Project name	Launch readiness date	Preliminary cost estimate (in millions)
Exploration	ARRM	Asteroid Robotic Redirect Mission	December 2020	\$1,720.0
	Europa	Europa	July 2022	\$3,000 – \$4,000
	Mars 2020	Mars 2020	July 2020	\$2,168 – \$2,351
	NISAR	NASA Indian Space Research Organization Synthetic Aperture Radar	December 2020	\$718 – \$808
	SWOT	Surface Water and Ocean Topography	October 2020	\$647 – \$757
Implementation			Launch readiness date	Current cost baseline (in millions)
	EGS	Exploration Ground Systems	November 2018	\$2,812.9
	GRACE-FO	Gravity Recovery and Climate Experiment Follow On	February 2018	\$431.9
	ICESat-2	Ice, Cloud, and Land Elevation Satellite-2	June 2018	\$1,063.5
	InSight*	Interior Exploration using Seismic Investigations, Geodesy, and Heat Transport	March 2016	\$675.1
	ICON	Ionospheric Connection	October 2017	\$252.7
	JWST	James Webb Space Telescope	October 2018	\$8,835.0
	OSIRIS-REx	Origins–Spectral Interpretation–Resource Identification–Security–Regolith Explorer	October 2016	\$1,121.4
	Orion	Orion Multi-Purpose Crew Vehicle	April 2023	\$11,283.5
	SPP	Solar Probe Plus	August 2018	\$1,553.4
	SLS	Space Launch System	November 2018	\$9,695.4
	SGSS*	Space Network Ground Segment Sustainment	September 2019	\$1,207.9
	TESS	Transiting Exoplanet Survey Satellite	June 2018	\$378.4
	CCP*	Commercial Crew Program	December 2017	\$6,800.0

Source: GAO analysis of NASA data. | GAO-16-461T

*In December 2015, NASA announced that InSight will not launch in March 2016 as planned due to problems with a key instrument that is being provided by an international partner. Information on the cost and schedule effects of this decision was not available at the time of our review.

*In February 2016, NASA reclassified SGSS as a sustainment effort, rather than a major project. Since SGSS was part of NASA's major project portfolio during our review, it is included in our assessment. Cost and schedule information in the figure reflects SGSS's July 2015 approved baseline. Its current cost and schedule is under review.

*The Commercial Crew Program is implementing a tailored version of NASA's space flight project life cycle, but it is currently completing development activities typically associated with implementation.

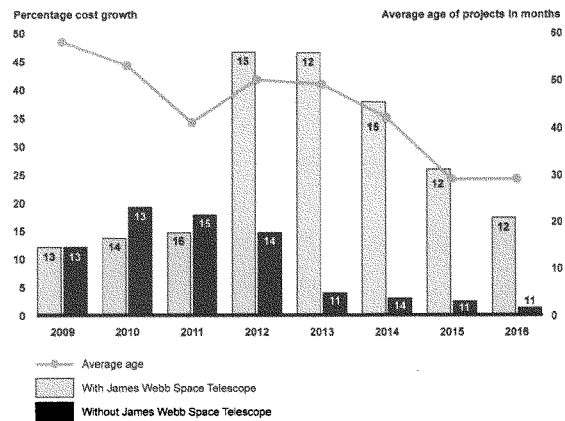
**NASA Cost and
Schedule
Performance and
Implementation of
Best Practices**

Our ongoing work indicates that NASA has made progress over the past 5 years in a number of key acquisition management areas, but it faces significant risks in some of its major projects. On the positive side, the cost and schedule performance of NASA's portfolio of major projects in development has improved and most current projects are adhering to their committed cost and schedule baselines. In addition, NASA has maintained recent improvements in the implementation of key product development best practices, which can help reduce risk in projects. Our preliminary results indicate that although NASA's overall performance has improved, its portfolio of major projects continues to experience cost and schedule growth and development risks in major projects, such as Orion and the Space Launch System, warrant the committee's continued attention.

**Overall Cost Performance
of the Portfolio**

Our preliminary results show that the cost and schedule performance of NASA's portfolio of major projects in development continues to improve. In 2016, overall development cost growth for the portfolio of 12 development projects, excluding the James Webb Space Telescope (JWST), fell to 1.3 percent and launch delays averaged 4 months. Both of those measures are at or near the lowest levels we have reported since we began our annual reviews in 2009 (see fig. 3).

Figure 3: Development Cost Performance and Average Months Spent in the Development Phase for Major NASA Projects from 2009 through 2016



Source: GAO analysis of NASA data. | GAO-18-461T

Note: Includes projects in development. The average age of projects is the average length of time projects in the portfolio have been in development or implementation.

NASA has made positive changes in the past 5 years that have helped contribute to the improved performance of its projects. Among other things, we previously reported that NASA adopted a new policy to help project officials with management, cost and schedule estimating, and maintenance of adequate levels of reserves; established a management review process to enable NASA's senior management to more effectively monitor a project's performance, including cost, schedule, and cross-cutting technical and nontechnical issues; and has improved external oversight by increasing transparency into project costs. Congressional action has also helped improve visibility into NASA's cost and schedule performance. In 2005, Congress required NASA to report cost and schedule baselines for all programs and projects with estimated life-cycle costs of at least \$250 million that have been approved to proceed to

implementation. Congress also required NASA to report to it when development cost growth or schedule delays exceeded certain thresholds.⁶

Our ongoing work indicates that NASA's most recent improvements in its overall cost performance have also been driven, in part, by the addition of new, large programs to the portfolio. The cost and schedule performance of any portfolio is affected by its composition. New projects are less likely to have experienced cost and schedule growth than older ones, so they generally help improve portfolio performance. Eight of the 12 major projects in development established baselines within the last 2 years, and cost and schedule performance collectively has improved as projects in the portfolio have become, on average, younger. We will continue to monitor these trends as NASA's current major projects progress through the project life cycle to see if the improvements in the portfolio's cost and schedule performance are sustained.

Project Rebaselines

Our ongoing work shows that most current NASA projects have stayed within the cost and schedule estimates in their development baselines, both this year and throughout their life cycles, but the portfolio continues to experience cost and schedule growth. This growth was driven by projects that experienced significant cost growth and exceeded their development cost baselines. When a project exceeds its development cost baseline by 30 percent, it is rebaselined if it is to be continued. NASA has rebaselined a major project each year for 8 out of the last 9 years. Table 1 shows the development cost growth for each of the rebaselined projects.

⁶National Aeronautics and Space Administration Authorization Act of 2005, Pub. L. No. 109-155, §103; 42 U.S.C. § 16613(b)(7)(4).

Table 1: Development Cost Growth on NASA Major Projects Rebaselined from 2007 through 2015

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
Rebaselined project	SOFIA	NPP	Glory	MSL	JWST	OCO-2 ^a	None	ICESat-2	SGSS ^b
Development cost growth (in millions)	\$813.8	\$254.9	\$168.7	\$812.8	\$3,607.7	\$71.3	Not applicable	\$204.8	\$308.7

Legend: SOFIA: Stratospheric Observatory for Infrared Astronomy; NPP: National Polar-orbiting Operational Environmental Satellite System Preparatory Project; MSL: Mars Science Laboratory; JWST: James Webb Space Telescope; OCO-2: Orbiting Carbon Observatory 2; ICESat-2: Ice, Cloud, and Land Elevation Satellite-2; SGSS: Space Network Ground Segment Sustainment.

Source: GAO analysis of NASA data | GAO-16-309SP

^aThe OCO-2 rebaseline was driven by launch vehicle failures, which were external to the project.

^bIn July 2015, NASA approved a new cost and schedule baseline for SGSS, which is reflected in the table. Subsequently, in February 2016, NASA reclassified SGSS as a sustainment effort, rather than a major project. Since SGSS was part of NASA's major project portfolio during our review, it is included in our analysis.

Our ongoing work also shows that the cost growth associated with rebaselined projects often overwhelms the positive cost performance within the remainder of the portfolio both on an annual and life-cycle basis. In July 2015, NASA approved a new baseline for the Space Network Ground Segment Sustainment (SGSS) project, which increased its estimated development costs from \$368 million to \$677 million and extended its completion date from June 2017 to September 2019. Cost growth from the SGSS was not offset by better performing projects, such as the Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx) asteroid sampling mission. OSIRIS-REx reported lower than expected development costs for the second consecutive year, even though it is at a stage in the life cycle when projects often realize cost growth. The project attributes its \$78.2 million decrease in development cost to several factors, including a mature mission concept and rigorous risk management process.

Our preliminary results indicate that the projects in NASA's current portfolio with the highest development costs, including Space Launch System and Orion, are entering the stage when most rebaselines occur. Projects appear most likely to rebaseline between their critical design and system integration reviews. All eight major projects that rebaselined during the last 9 years did so after their critical design review and the three projects in the 2016 portfolio that rebaselined did so before holding

their systems integration review.⁷ Nine projects in the current portfolio are in this stage of development— Exploration Ground Systems; Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2); Ionospheric Connection (ICON); JWST; Orion; SGSS; Space Launch System; Solar Probe Plus (SPP); and Transiting Exoplanet Survey Satellite (TESS). Three projects—ICESat-2, JWST, and SGSS—have already rebaselined. If a rebaseline occurs on any of the other six projects, it could add anywhere from almost \$60 million to more than \$2 billion to the development cost of the portfolio. We will continue to examine these nine projects as part of our annual assessments until they launch, but they also warrant the committee's continued oversight attention.

Our ongoing work has also found that the Space Launch System and Orion, the two largest projects in this critical stage of development, face cost, schedule, and technical risks. For example, the Space Launch System program has expended significant amounts of schedule reserve over the past year to address delays with development of the core stage, which is the Space Launch System's propellant tank and structural backbone. The Orion program continues to face design challenges, including redesigning the heat shield following the determination that the previous design used in the first flight test in December 2014 would not meet requirements for the first uncrewed flight. The standing review boards for each program have raised concerns about the programs' ability to remain within their cost and schedule baselines. If cost overruns materialize on these programs, they could have a ripple effect on the portfolio and result in the potential postponement or even force the cancellation of projects in earlier stages of development. We have ongoing work on both of these programs and we plan to issue reports on them later this summer.

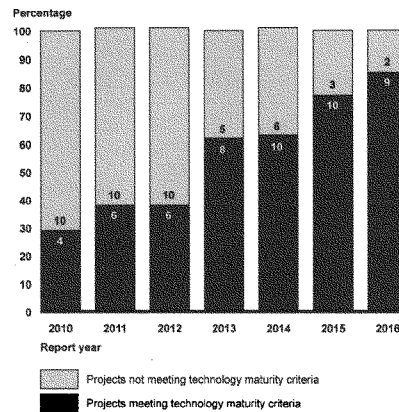
**Implementation of
Development Best
Practices**

Our ongoing work indicates that NASA has maintained recent improvements in the technology maturity and design stability of its projects as measured against best practices. As of 2015, 9 of the 11 major projects in NASA's 2016 portfolio that have passed the preliminary design review have matured all heritage or critical technologies to a

⁷Four of the eight rebaselined projects did not hold a systems integration review. NASA established this milestone in 2007 after four of the eight projects were originally baselined and therefore it was not a requirement for these projects.

technology readiness level (TRL) 6—a large increase since 2010 (see fig. 4). The 12th project in development, Exploration Ground Systems, did not report any critical or heritage technologies, so it was omitted from this analysis.

Figure 4: Percentage and Number of NASA's Major Projects Attaining Technology Maturity by Preliminary Design Review from 2010 through 2016



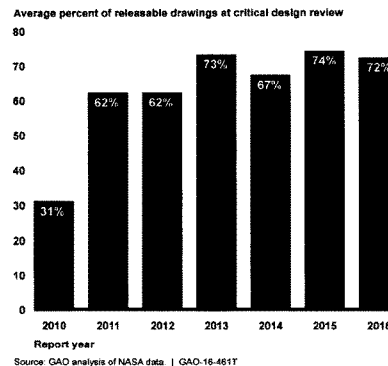
Source: GAO analysis of NASA data. | GAO-16-461T

Our prior best practices work has shown that reaching a TRL 6—which indicates that a representative prototype of the technology has been demonstrated in a relevant environment that simulates the harsh conditions of space—can minimize risks for space systems entering product development. Projects falling short of this standard before the preliminary design review, a milestone that generally precedes the project's final design and fabrication phase, may experience subsequent technical problems, which can result in cost growth and schedule delays.

Our ongoing work indicates that NASA has also sustained improvements it has made since 2010 in the design stability of its major projects. The average percentage of engineering drawings released at critical design

review for NASA's 2016 portfolio of major projects was 72 percent, roughly the same percentage as last year. This is a significant improvement since 2010, but is still short of the GAO-identified best practice of 90 percent (see fig. 5). Further, a majority of projects in development maintained mass and power reserves that met or exceeded NASA requirements. NASA projects have also continued to minimize design changes after the critical design review—another measure of design stability.

Figure 5: Average Percentage of Releasable Engineering Drawings for NASA Major Projects at Critical Design Review from 2010 through 2016



Our prior work on product development best practices shows that at least 90 percent of engineering drawings should be releasable by the critical

design review to lower the risk of subsequent cost and schedule growth.⁸ The NASA Systems Engineering Handbook also includes this metric. In 2012, NASA established additional technical leading indicators to assess design maturity. These indicators include (1) the percentage of actual mass margin versus planned mass margin and (2) the percentage of actual power margin versus planned power margin.⁹ NASA has updated its project management policy and its systems engineering policy to require projects to track these metrics. Projects that do not achieve design stability by critical design review may experience design changes and manufacturing problems, which can result in cost growth and schedule delays.

Management Challenges

NASA's portfolio is composed of a few large projects that face a lot of pressures and challenges. Any cost growth within these projects can have grave consequences for smaller projects that are critical to a number of scientific endeavors. In November 2015, the NASA Office of the Inspector General issued its annual report on NASA's top management and performance challenges.¹⁰ Examples of challenges

⁸Engineering drawings are considered to be a good measure of the demonstrated stability of a product's design because the drawings represent the language used by engineers to communicate to the manufacturers the details of a new product design—what it looks like, how its components interface, how it functions, how to build it, and what critical materials and processes are required to fabricate and test it. Once the design of a product is finalized, the drawing is "releasable." The critical design review is the time in the project's life cycle when the integrity of the project design and its ability to meet mission requirements is assessed. It is important that a project's design is stable enough to warrant continuing with the final design and fabrication phase. If a project experiences a large amount of drawing growth after critical design review, this may be an indicator of instability in the project design late in the development cycle. A stable design allows projects to "freeze" the design and minimize changes prior to beginning the fabrication of hardware, after which time reengineering and re-work efforts due to design changes can be costly to the project in terms of time and funding.

⁹Mass is a measurement of how much matter is in an object. It is related to an object's weight, which is mathematically equal to mass multiplied by acceleration due to gravity. Margin is the spare amount of mass or power allowed or given for contingencies or special situations. Some centers provide additional guidance for mass margins including frequency of reporting and the percentage of mass margin required at various points in project development, with required margins ranging from 30 to 0 percent, depending on where a project is in the development cycle.

¹⁰National Aeronautics and Space Administration, Office of the Inspector General, *NASA's Top Management and Performance Challenges, November 2015*, (Washington, D.C.: November 2015).

identified in the report include managing NASA's science portfolio, space flight operations in low earth orbit, positioning NASA for deep space exploration, and securing NASA's information technology systems and data. We agree with the challenges identified by the Inspector General and our ongoing and prior work has highlighted additional areas where it will be important for NASA to continue its efforts to reduce acquisition risk, including implementing project management tools, demonstrating sustained cost and schedule performance, and developing plans that will help the agency appropriately direct future investments.

Implementation of Management Tools

As part of our ongoing work, we found that NASA is taking steps to improve its project management tools but has not yet fully implemented best practices.

Earned Value Management. NASA has made progress implementing earned value management (EVM) analysis—a key project management tool—but the agency has not yet fully implemented a formal EVM surveillance plan in accordance with best practices. EVM has been a critical part of the agency's efforts to understand project development needs and to reduce cost and schedule growth. When implemented well, EVM integrates information on a project's cost, schedule, and technical efforts for management and decision makers by measuring the value of work accomplished in a given period and comparing it with the planned value of work scheduled for that period and the actual cost of work accomplished. NASA has made progress rolling out EVM at its centers and is supporting these efforts with training, including classroom and online training to projects at its various centers.

In 2012, we recommended that NASA require projects to implement formal EVM surveillance programs. NASA partially concurred, but according to NASA officials, they have not implemented the recommendation due to resource constraints.¹¹ Proper surveillance of EVM contractor data is a best practice in the NASA Earned Value

¹¹Beyond reviewing cost and schedule variances and variances at completion, formal surveillance reviews ensure that the processes and procedures continue to satisfy the guidelines. A formal surveillance plan involves establishing an independent surveillance organization with members who have practical experience using EVM. This organization then conducts periodic surveillance reviews to ensure the integrity of the contractor's EVM system and where necessary discusses corrective actions to mitigate risks and manage cost and schedule performance. GAO-13-22.

Management Implementation Handbook and GAO's Cost Estimating and Assessment Guide.¹² Without implementing proper surveillance, a project may be utilizing unreliable EVM data to inform its cost and schedule decision making. NASA has taken other steps to address the intent of our recommendation, but we continue to find issues with the quality of EVM data. In our December 2015 review of the James Webb Space Telescope, we found project EVM data anomalies and recommended that project officials require the contractors to explain and document all such anomalies in their monthly EVM reports.¹³ A continuous surveillance program could have identified these anomalies earlier, allowing the project to pursue corrective action with its contractors. NASA concurred with this recommendation and recently sent us documentation concerning steps it has taken to address it. We are currently reviewing that information to determine if NASA has implemented the recommendation.

Joint Confidence Level. In 2009, in order to ensure that cost and schedule estimates were realistic and projects thoroughly planned for anticipated risks, NASA began requiring that programs and projects with estimated life-cycle costs of \$250 million or more develop a JCL prior to key decision point C.¹⁴ However, there is no requirement for NASA projects to update their JCLs and our prior work has found that projects do not regularly update cost risk analyses to take into account newly emerged risks.¹⁵ Our cost estimating best practices recommend that cost estimates should be updated to reflect changes to a program or kept current as it moves through milestones.¹⁶ As new risks emerge on a project, an updated cost risk analysis can provide realistic estimates to decision-makers, including the Congress. This is especially true for NASA's largest projects as updated estimates may require the Congress to consider a variety of actions.

¹²GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: Mar. 2, 2009).

¹³GAO-16-112.

¹⁴A JCL is a tool which assigns a confidence level, or likelihood, of a project meeting its cost and schedule estimates.

¹⁵GAO-13-4 and GAO-15-596.

¹⁶GAO-09-3SP.

Schedule Development. Our best practices work stresses the importance of a reliable schedule because not only is it a road map for systematic project execution, but also a means by which to gauge progress, identify and resolve potential problems, and promote accountability.¹⁷ According to NASA officials, a project's ability to efficiently execute a quality JCL analysis is directly tied to the quality of the underlying data, especially a project schedule. Independent assessors—a group of technical experts within NASA who do not actively work on a specific project or program—noted that when they are reviewing a project's JCL, one of the most common areas that projects struggle with is developing a reliable schedule. For example, our ongoing work found that the Orion program's standing review board raised concerns that the program's schedule is missing activities which could affect the program's ability to accurately identify what is driving the schedule. Officials in NASA's Cost Analysis Division told us that various schedule related tools have been developed and already made available to projects and additional tools are in development.

**Sustained Cost and
Schedule Performance**

A key management challenge that NASA faces is whether the improvement in the cost and schedule performance we have seen in the agency's overall portfolio of major projects can be translated to new, large projects that have been recently baselined and added to the portfolio. These additions include its human spaceflight projects, which includes the Space Launch System, Orion, and Exploration Ground Systems program that is developing systems and infrastructure to support assembly, test, and launch of the Space Launch System and Orion. In our February 2015 High Risk Update, we noted that NASA's human spaceflight projects are at critical points in implementation and, as I noted earlier, we found that all three projects are entering the stage where most project rebaselines appear most likely to occur—between their critical design and system integrations reviews.¹⁸ This is an area where the agency has not been tested since a similarly large and complex project, the James Webb Space Telescope, underwent a replan in September 2011 that resulted in a 78 percent increase in life-cycle costs—increasing to \$8.835 billion—and a schedule delay of 52 months—delaying the planned launch date to

¹⁷GAO, *GAO Schedule Assessment Guide: Best Practices for Project Schedules* GAO-16-69G (Washington, D.C.: Dec. 22, 2015).

¹⁸GAO-15-290.

October 2018. In addition, NASA will have to demonstrate that it is able to sustain cost and schedule performance in its Commercial Crew Program, which is NASA's effort to facilitate the private demonstration of safe and reliable transportation services to carry NASA astronauts and cargo to and from the International Space Station. NASA is partnering with commercial providers and its approach includes tailoring its spaceflight project life cycle. Our high-risk report identified key areas where NASA could better anticipate and mitigate risks with respect to these human spaceflight programs, including ensuring that adequate and ongoing assessments of risks are conducted given that the impacts of any potential miscalculations will be felt across the portfolio, ensuring that projects' JCLs are updated regularly, and ensuring that the long-term project costs are understood.

Long-Term Planning and Stability

Our ongoing and prior work has also found that NASA has established cost and schedule baselines for the Space Launch System, Orion, and Exploration Ground Systems, but the baselines provide little visibility into long-term planning and costs. The baselines for the Space Launch System and Exploration Ground Systems are through the first Exploration Mission (EM-1), during which NASA plans to fly an uncrewed Orion some 70,000 kilometers beyond the moon, and the Orion program's baseline is through the second Exploration Mission (EM-2), which NASA plans to fly beyond the moon to further test performance with a crewed Orion vehicle. In October 2015, NASA issued its *Journey to Mars*, which NASA identifies as a document that, among other things, communicates its strategy and plans to get to Mars.¹⁹ However, the document does not provide additional details on future exploration missions, making it difficult to understand NASA's vision for what type and how many missions it will take to get to Mars. Without this information, decisionmakers do not have visibility into how NASA expects to invest to develop, operate, and sustain a capability over the long term. Having a complete picture of costs can enable both the Congress and the administration to set priorities for both the short and long term. In May 2014, we recommended that NASA establish separate cost and schedule baselines for each additional capability that encompass all life-cycle costs, to include operations and

¹⁹NASA, *NASA's Journey to Mars: Pioneering Next Steps in Space Exploration*, NP-2015-08-2018-HQ (Washington, D.C.: Oct. 2015).

sustainment.²⁰ NASA partially concurred with our recommendation and stated that it had established separate programs for Space Launch System, Orion, and Exploration Ground Systems. Further, NASA stated that the Space Launch System program had gone further by adopting a block upgrade approach to ensure more realistic long-range investment planning and more effective resource allocations through the budget process. However, NASA stated that it does not intend to carry life-cycle estimates for the Space Launch System program through an end-of-program date because the strategic parameters of such analysis are in the process of being defined. NASA has yet to take action on this recommendation.

**The Space Leadership
Preservation Act of 2015**

The various provisions of the act being discussed today propose changes in NASA's leadership structure and long-term contracting authorities, among other areas. In a prior testimony, sponsors of the act emphasized that the provisions are aimed at making NASA more professional and less political by giving the agency greater stability. The concept of stability is an important one for NASA since projects require heavy investments—both in terms of time and money—and require cooperation and support from a variety of communities, who sometimes have competing interests, including academic institutions, partnering countries, the science community, and industry, to name a few. We have not studied how the act's specific provisions, including the types of leadership structures being proposed, could affect stability for NASA's projects. However, based on our prior work on NASA's and the Department of Defense's (DOD) acquisition management efforts, we would like to offer the following observations:

- If NASA were to implement a board of directors as outlined in the proposed legislation, the board itself must be willing to hold program managers and leadership accountable by canceling programs that do not perform well. If programs with an unsound business case are allowed to continue, their poor performance could have dramatic consequences on the overall portfolio. Insight into program performance, independent assessments, and regular reporting on

²⁰GAO, *NASA: Actions Needed to Improve Transparency and Assess Long-Term Affordability of Human Exploration Programs*, GAO-14-385 (Washington, D.C.: May 8, 2014).

progress are all necessary tools to enable leadership to hold managers accountable.

- DOD has used multiyear contracts under other authorities to acquire weapon systems and believes these tools are helpful in negotiating lower prices. However, longer term commitments to contracts will not necessarily produce better results if they are not accompanied by best practices.
- Our past work at DOD has found that it is difficult to precisely determine the impact of multiyear contracting executed under a different authority on actual procurement costs and that savings did not appear to have materialized as expected in budget justifications to Congress in three case studies we looked at, and ultimately more funding was needed to buy the systems.²¹ Further, multiyear procurement contracts can provide stability for contractors doing business with the government, but they also can reduce Congress's and NASA's flexibility in making changes to programs and budgets unless the government is willing to pay the cancellation fees associated with doing so.

In closing, I would like to emphasize that achieving stability through leadership and contracting changes may offer benefits, but one of the most important factors in achieving stability is a sound business case that balances the necessary resources—technologies, design knowledge, funding, and time—needed to transform a chosen concept into a product. As our ongoing and prior work shows, more effort is still needed to improve NASA's cost estimating, scheduling practices, and contractor oversight. Robust, long-term plans and realistic estimates are also needed to guide decisions and to secure longer term support. We look forward to continuing to work with NASA and this Committee in instituting these improvements.

Chairman Smith, Ranking Member Johnson, and Members of the Committee, this completes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

²¹GAO, *Defense Acquisitions: DOD's Practices and Processes for Multiyear Procurement Should Be Improved*, GAO-08-298 (Washington, D.C.: Feb. 7, 2008).

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Cristina T. Chaplain
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Ms. Chaplain currently serves as a Director, Acquisition and Sourcing Management, at the U.S. Government Accountability Office. She has responsibility for GAO assessments of military space acquisitions, NASA, and the Missile Defense Agency. Among other topics, she has led reviews on the international space station, the Space Launch System, acquisition progress for major NASA projects, the James Webb telescope, commercial cargo and crew, NASA contract management, contract terminations and the evolved expendable launch vehicle. In addition to her work on space and missile system development, Ms. Chaplain has led a variety of DOD-wide contracting-related and best practice evaluations for the GAO. Before her current position, Ms. Chaplain worked with GAO's financial management and information technology teams. Ms. Chaplain has been with the GAO for 25 years. She received a bachelor's degree, magna cum laude, in International Relations from Boston University and a Masters Degree in Journalism from Columbia University.

Chairman SMITH. Okay. Thank you, Ms. Chaplain, and thank you all for your testimony today. I appreciate your candor and directness both.

Dr. Griffin, let me address my first question to you, and actually this is a question from Chairman Culberson, and that is, how would you design a process to create a human spaceflight Decadal Survey?

Mr. GRIFFIN. Such a question reminds me of a rye joke among engineers about the dangers of doing math in public. With that in mind, I think I might offer some broad comments——

Chairman SMITH. Okay.

Mr. GRIFFIN. —but—and I would be more than willing to discuss the question offline——

Chairman SMITH. Okay.

Mr. GRIFFIN. —with Committee and staff. But the details are probably not best hammered out here. I would say broadly that, in order to craft a plan of decadal scope, a process much like what science does in their various disciplines would be helpful. One would have to gather together recognized experts in human spaceflight ranging from operators to, in point of fact, philosophers. Why are we doing this in the first place? These were the kinds of questions that were addressed in the period following the loss of Columbia and that did allow us to come up with what I thought was a plan, a quality plan of decadal scope.

Chairman SMITH. Okay.

Mr. GRIFFIN. The key to such a plan is having as many knowledgeable stakeholders as possible contributing to it, having it done in the open, and then having the opportunity to discuss it and debate it when it's done rather than having it, as Colonel Collins suggested, foisted upon us as a surprise.

Chairman SMITH. Okay. Thank you, Dr. Griffin. We'll look forward to a further discussion——

Mr. GRIFFIN. All right.

Chairman SMITH. —on the subject with you as well.

Mr. GRIFFIN. I would as well, sir. Thank you.

Chairman SMITH. Great. Colonel Collins, does NASA have a set of clearly defined strategic goals and objectives? And if not, what should those goals and objectives be?

Ms. COLLINS. Yes, thank you for the question. I think it depends on your perspective because some say yes and some say no, so I think at the top NASA does have a final goal of landing a crew on Mars approximately 2030, 2033. But how you get there is where there is maybe disagreement or some confusion possibly on how we're going to do that because the mission has changed and NASA has defined the roadmaps and they are in those National Academy of Sciences' studies that have been published, one in 2012 and one in 2014.

We go there by using the moon as a testbed or by visiting an asteroid, and I realize the asteroid mission has changed several times. It was originally astronauts would visit an asteroid and work there, and as time went on, the asteroid got smaller. It was difficult to find the right asteroid. One of the problems is these asteroids are moving around in space so they're not always where you think they're supposed to be. You have to project where it's going

to be in the future, and then if your mission delays, that's going to change some of the planning and possibly may even change the destination to a different asteroid. And of course all these asteroids are different and they have different makeups, different sizes.

So NASA then decided to capture an asteroid and bring it to the lunar space, do that robotically, and then have astronauts visit. So that mission has changed because, as we go along, we find that there's technical difficulties.

So I see that that's where the disagreement is in the scientific and operational community as to how we should do that mission. Most people agree that we need to go to Mars. The problem is how do we get there?

Chairman SMITH. Thank you, Colonel Collins.

And, Ms. Chaplain, what are your recommendations for how NASA should address their deficiency in their proposal to go to Mars?

Ms. CHAPLAIN. I think the long-term planning is very critical here, and they do definitely need a strategic plan that, again, lays out how they're going to get there, also what technologies you need to get there. There's many more systems and subsystems that are going to need to be developed for the eventual trip to Mars, and to also have cost estimates at least in ranges for the different kinds of choices that you can make. At this point, we only have cost estimates going up through the second flight for Orion and nothing after that. And for SLS we only have cost estimates going up through the first flight, so there's a lot of important questions ahead about how much is everything going to cost and what else do you need to get in order to get there.

Chairman SMITH. Okay. Thank you, Ms. Chaplain.

The Ranking Member, the gentlewoman from Texas, Ms. Johnson, is recognized for her questions.

Ms. JOHNSON. Thank you very much, Mr. Chairman.

Ms. Chaplain, based on GAO's work on NASA, what are the top two issues that need to be addressed to ensure stability in NASA's programs over the long term and what should Congress do to address those? And would any of the other witnesses care to comment after you?

Ms. CHAPLAIN. So that's a good question. I think it speaks to the levels of discussion that we're having. One is a good strategic long-term plan that helps provide stability, and the plan itself, if it has agreement from a lot of different communities, you have a better chance of maintaining support over the decades that need to happen.

But at the more tactical level, acquisition programs have to be well-managed, too, and Congress has done a lot for NASA in that regard by helping them get more transparency into costs and progress, instituting good metrics and project management tools. There's always more that can be done, especially in terms of holding programs accountable when they don't meet their goals and they don't have good plans for going forward. But I see the solution as being on both those levels.

Ms. JOHNSON. Any other witnesses care to—

Mr. GRIFFIN. No, I don't need to comment further at this time. Thank you, ma'am.

Ms. JOHNSON. Okay. Okay.

Ms. COLLINS. The question was on the top two things that NASA could do? I think that—although I'm not a policy or budget expert, I think that there may be something in a multiyear funding that seems to make sense.

And the other comment I have is on the Board of Directors that we had heard mentioned earlier today. I think the key thing about having a Board of Directors in adding stability is getting the right people on that board that are entirely independent. And I serve on several boards, and I think the key to having a board that works very well and very healthy is getting people that love the mission, have a passion for the mission, and are good listeners and can listen to all sides of the issue before they come in with their recommendation and their good governance. So I think that where there could be problems with that I think is something that's worthy of looking at.

Ms. JOHNSON. Thank you. This Committee and Congress will be considering and deliberating on the budget—the President's fiscal year budget 2017 in the coming weeks. What in your view are the top three challenges for NASA over the next two years?

Mr. GRIFFIN. Ms. Johnson, I don't know that I would have a top three. I think the topic of this hearing today is a critical one. What should NASA be doing? What as a nation do we want to do with our civil space program? I personally have been very clear that I think the proper next step is a human lunar return. That will occupy us in the near term and allow us to cement the international partnerships that helped us to build the space station.

Beyond that, we should be doing everything that we do in returning to the moon in such a way that it has maximum applicability toward going to Mars. As Colonel Collins has said, this is something the United States can do, and I believe it's something that we should do.

And so if I get my top three, the third thing I would say is once these goals are locked in place by the legislature, I think we need a cultural change. Our program is not something which the Nation can afford to have be a playground for newly elected Presidents and unelected staff. The legislature is the proper repository of the long-term stability in these plans and programs that we need, and it needs to be enforced. Thank you, ma'am.

Ms. JOHNSON. Thank you.

Ms. COLLINS. I had a minute to think about the question. You asked about the top three important things for NASA. I would say first is most people know American astronauts right now have to go to Russia and train in Russia to get to our space station. So of course a very top issue is getting launch from our country's soil, our astronauts to our space station, which I understand is funded through 2024.

The second I believe is heavy launch, obviously for our long-term space goals, and the third is getting the best people. We need to get the smartest people into NASA by going out and recruiting, and the best way to do that is having a mission that they believe in.

Mr. GRIFFIN. I'd like to echo my support for Eileen's comment that we need to restore American access to space as soon as pos-

sible. That might have been something I was assuming was a given, and I think I should state it explicitly. Thank you.

Ms. JOHNSON. My time is expired, but I'd like you to comment if you could.

Ms. CHAPLAIN. So I'll be quick in light of that. To add to the conversation just to note that some of the largest programs will be entering their most difficult phases of development where we tend to see more cost growth and more problems. So getting through those couple of years and ensuring issues that happen on these huge programs don't affect and overwhelm the smaller programs that are equally important.

Ms. JOHNSON. Thank you, Mr. Chairman.

Chairman SMITH. Thank you, Ms. Johnson.

The gentleman from Florida, Mr. Posey, is recognized.

Mr. POSEY. Thank you very much, Mr. Chairman, for scheduling the Space Leadership Preservation Act hearing. I thank all the panelists for appearing and for their wisdom and foresight that you've shared with us so far.

You know, I've heard a lot of criticism from different directions about this proposed legislation, but I've not heard one single person propose an actual solution to the problem that we have of lack of programming and foresight and how we're going to get on track and stay on track and keep America's space program first.

Mr. Chairman, I think you brushed over the beginning a litany of events that kind of throws us into instability even more. I mean, we have a candidate that runs for office that says if he's elected President, he's going to abolish NASA and put the money into education. Then, when he appears on the space coast, he says I'm going to close the gap between the shuttle in Constellation and keep America first in space. Then, he gets elected and he asks for the NASA Administrator's resignation, and he doesn't fill the position. So when they're doing their planning and strategic planning for the Administration's future, the NASA Administrator seat is empty. That's kind of a shame.

So then we get a great NASA Administrator appointed, and then we have an Augustine Commission appointed—I may have these two out of order a little bit—to tell him what to do. And the Augustine Commission says, of course, the shuttle is terribly dangerous and needs to be scuttled.

We all know better than that. We know they were designed for over 100 missions and they were only in the 35th mission, mile per mile the safest space travel of any kind in the history of mankind. And we know the catastrophes, the tragedies were human error. It wasn't any failure of NASA.

And so then we go in a different direction and we have SLS and Orion now, which I think are great plans, great goals, but we have an Administration that frankly underfunds them. They suggest them, promote them, and then underfund them. So then NASA ends up being criticized that they can't keep up schedules that they'd foreseen before, and we know that when you delay projects and instability is going to cost increases, too.

So, you know, you have to wonder if you are NASA or you're a NASA employee or a potential NASA employee or even just a bright STEM student or, like the 18,000 who applied to be astro-

nauts, what is our future going to be? What is our future going to be? And I love Neil deGrasse Tyson when he says, you know, our investment in space is fundamentally basically the only thing our Congress does strictly for future generations, to benefit future generations.

And so I think Congressman Culberson's bill is much too important to ignore not only for those reasons but for reasons of national security, our technological advancement, and eventually, the survival of our species.

Now either Dr. Griffin and Colonel Collins, China is rapidly developing the capability to access and use all regions of cislunar space. If the United States cedes that and moon base sole use to China, what do you foresee as the strategic and long-term impacts on the national interest of our country?

Mr. GRIFFIN. Well, you mentioned me first, so I'll go first, Mr. Posey. Thank you. I have a couple comments on that. First of all, I think you can infer all that needs to be inferred about how the Chinese will behave in space by watching today how they are behaving in the Western Pacific and the concern that that causes not only the United States but all nations in that region. There is no reason to suppose that they would behave any differently in space, and I think that should give us concern.

More broadly, since World War II, the United States has been a superpower and one certainly would say, I think, the superpower in the world. The world is a better place when that situation is so. I believe Western values and customs and respect for individual rights and the rule of law matter. If we want those cultural values to prevail upon in the new frontier that is space, then we will have to be there. The decisions are made by the people who show up, not by the people who watch on TV.

For those reasons, which I believe are existential for our culture, we need to be in space first among equals irrespective of what China or any other nation seeks to do. Thank you.

Mr. POSEY. Thank you. Colonel?

Ms. COLLINS. When the Apollo 11 crew landed on the moon, 1969, they put a plaque that said, "We came in peace for all mankind." I'm not sure China would put a plaque like that on the moon.

I am concerned about China. I'm not an expert on China, so I'll get that in the record. But I'm not sure what their intentions are. And as Dr. Griffin said, we can only guess based on what they're doing now, what their performance is. We don't really cooperate with China in space although we cooperate with all other nations, and I believe in international cooperation. Whether or not we cooperate with the Chinese is a big question mark. It's just a little bit scary, and sometimes, part of me says competition is good in many ways, and if we ever end up in a race back to the moon against China, that might give us a little kick in the pants—

Mr. POSEY. Okay.

Ms. COLLINS. —to get out there and do it, whether it's the moon or Mars or whatever we're doing in space.

Mr. POSEY. Okay. Thank you.

Thank you for your indulgence, Mr. Chairman.

Chairman SMITH. Thank you, Mr. Posey.

The gentleman from Colorado, Mr. Perlmutter, is up next.

Mr. PERLMUTTER. I'm way down here. Thank you very much to the panelists. Thank you to Chairman Culberson for bringing his bill before us.

And there are a lot of principles that I think we all share. Sometimes, you lose sight of those when you take shots at each other's party or each other's President. I remind my friends on the Republican side of the aisle, did the math, and I did this in public, 2016 minus 1972, it's been 44 years since we've been on the Moon and 24 of those years we've had Republican Presidents and 20 of those years we've had Democrats. So we need to get back into space.

And whether—so for me—and my colleagues know that I like this time frame to get us to Mars, when the planets lineup, it's time to get there. We set an outside date, 2033. That's a responsibility of us on the political side whether it's the Administration or Congresses, which change every 2 years.

So I'm going to give my friend, who's the Chairman of CJS, the benefit of the doubt because he's been through this. And if there's some way that we can put together a structure that takes out the vagaries of each Congressional election and each presidential election and gets us to Mars by 2033 and you folks with the engineering degrees and the physics degrees and the accounting degrees figure out how to put the building blocks in place, then I'm there. That's your job. My job is to find you the money.

And we've had testimony that over the course of—to get to Mars is \$200 billion plus. That's a lot of money. But we found \$800 million for the banks over a weekend. We found \$250 billion a year to be in Afghanistan and Iraq. We can do this.

So, I'd like to have some kind of structure at NASA that allows for long-term thinking. So I'll start with you, Ms. Collins. You said you didn't have a real position on the Chairman's bill, but what would you do that—what would you say to me? How can we put long-term planning into place when we have two-year cycles for Congress and four-year cycles for the President?

Ms. COLLINS. Well, thank you for the question. I think—well, first of all, let me say our system of government is the greatest in the world, and I think that discussions that we have are wonderful. We get things out on the table. We have disagreements. I think the end goal—everybody's goal is the same. We want to have a strong human spaceflight program with a mission, we want to succeed, we want to get there at the best cost, and we want to do it safely. We don't want to hurt anybody in the process.

My first answer I would say is don't give up. So this applies on all levels. I mean, we did give up on Constellation. I think that the reason given was the cost, and yes, the cost was high. I mean, we all admit that. But instead of just giving up on the whole program—and I'm talking about not the past; I'm talking about the future here if this happens again. Let's just take a good hard look at can we—where can we cut the fat? Do we have the right people in there working the program? Maybe there's changes that need to be made, but we don't really need to give up on the end mission once that's been defined. We might need to change course a little, but keep—don't give up. Keep the mission in sight.

Mr. PERLMUTTER. In mind. So for me—and I really agree with a lot of the things that Mr. Posey said and some of the others, you know, that there is—there are two pieces to this. One is our basic desire to learn, science and exploration, to get to Mars, to be in space. The second is a national security question. And so between the two of them we ought to be able to get out there and get going for a long time, for however it might be.

So, Dr. Griffin, you've had your taste of political science and obviously you're a scientist as well. So as Administrator, you've been—you've run into both buzz saws. So how would you—you know, just saying, hey, you guys got to have a longer-term approach to this, what would be your view? How do we do it?

Mr. GRIFFIN. Thank you, Mr. Perlmutter. I cannot resist going for the simplest possible explanation or recommendation. I've been very clear in today's testimony and on earlier occasions that I very much admired the authorization bills of 2005 and 2008, which this Congress passed and frankly were originated in this Committee. The 2010 bill was also a good bill.

When proposals are made by the executive branch that conflict with the existing law, why does Congress go along? I have to say, had Congress merely made it extraordinarily clear to the incoming Administration that while that Administration had many problems before it, space was not one of those problem, that the Congress had decided upon the space plan, the space policy of the United States, and that policy would be kept. Had that been communicated, we would not be sitting here having this hearing today.

I said earlier in my testimony that I've regarded the Congress as the long-term body of stability if you will in the political system to capture the desire that Americans generally have for a particular course of action, to capture that in legislation, and to preserve it. If we treated our Navy the way that we treat NASA in terms of stability, we would not be able to project power upon the oceans the way that we do.

It takes as long to build an aircraft carrier as it took to go to the moon even when people are really working hard at it. If we decided with every incoming Administration whether we were going to preserve aircraft carriers, the United States would have none.

So I'll simplify my comments. The first recommendation I would have would be let us again, as we did after the loss of Columbia, decide as a nation what we want to see accomplished in space. Let us, as we did after Columbia, codify that into law. And then let us obey the law.

Mr. PERLMUTTER. Okay. Thank you.

Mr. GRIFFIN. Thank you, sir.

Mr. PERLMUTTER. And I thank the Chairman for letting me go over. And I want in the law that we're going to be on Mars by 2033.

Mr. GRIFFIN. I'm not fighting that.

Chairman SMITH. Thank you, Mr. Perlmutter. We're with you on 2033.

And the gentleman from Oklahoma, Mr. Bridenstine, is recognized for his comments.

Mr. BRIDENSTINE. Thank you, Mr. Chairman.

And I would like to say to my friend Mr. Perlmutter—actually to the Chairman if it's all right—I think we should have our own sticker that says 2032. We don't want to settle for 2033. Republicans ought to go for 2032.

In 1982, President Reagan reorganized our Navy's Nuclear Propulsion Program, citing the need to preserve structures and policies. While ensuring the program continues to function smoothly and efficiently, he ordered that the director of this program of great national import be appointed for an eight-year term. This change ensured that the leadership and direction of our nuclear Navy remained constant over at least, at least two presidential cycles if not multiple Administrations.

Likewise, NASA is an agency carrying out programs of national importance, which by their very nature take years, as Dr. Griffin just talked about, if not decades, to formulate, develop, and carry out. It makes complete sense to me to remove the Administrator of NASA from the political cycles in order to allow for continuity and stability.

I am proud to be a cosponsor of Chairman Culberson's bill, which proposes a ten-year term for the NASA Administrator. The Space Foundation's pioneering doctrine recommends a term of five years. I am working on legislation that includes a provision that establishes a five-year term as well. Regardless of the number, however, it seems that there is growing consensus among stakeholders and advocates to set the length of the Administrator's term beyond the standard political cycles.

Ms. Chaplain, while you focus mostly on space programs, have you gotten a sense from your time at GAO of the differences in how NASA acquisitions differ from those of government agencies that are run by nonpolitical or nontraditional heads? Have you seen a difference in how those acquisition strategies go?

Ms. CHAPLAIN. Most of the agencies with large acquisitions and complex ones like NASA do have political appointees. We don't get too much insight into the intel world, and that might be something to look at, but they're still political there, too. So I don't have a model there to look at.

There—other situations—agencies that have longer-term ten years for Administrators, GAO is actually one of them. We have a 15-year appointment for our Comptroller General, and the purpose is to keep the politics out of our work.

Mr. BRIDENSTINE. Sure.

Ms. CHAPLAIN. So there are other good models out there.

Mr. BRIDENSTINE. But from your assessment, and maybe you don't make assessments since you're with GAO, but those kind of models, are they better at—

Ms. CHAPLAIN. We don't have one that looks at that from an acquisition perspective.

Mr. BRIDENSTINE. Okay.

Ms. CHAPLAIN. There's also other space agencies internationally that have boards and different structures that could be looked at, but we haven't done that ourselves.

Mr. BRIDENSTINE. Okay. And, Mr. Griffin, when you think about some of the stumbles, obviously your testimony today at the beginning, talking about, you know, 2010 and beyond with NASA and

some of the stumbles that we've encountered, if your term had been extended and you would have been the Administrator, can you share with us how things might have been different?

Mr. GRIFFIN. Well, sir, I don't know that they would have been because Administrators and appointees take orders from the chief executive.

Mr. BRIDENSTINE. I see.

Mr. GRIFFIN. If the chief executive really wanted to change the space program, then I would have had the choice of either following orders or resigning. Had I been given the orders that my successor was given, I would have resigned because I thought, as I said now multiple times, I thought that the direction of Congress in 2005 and '08 was extraordinarily good. I believed we were on the right path and should maintain it. Therefore, if ordered to deviate from that path, I would not have remained.

I think, again, the issue—I have no objection to considering a five-year term, a six-year term, an eight-year term, whatever length of term for the Administrator, nor do I have any objection with the way it's done today. I think these kinds of discussions are a symptom of the problem we face, which is a lack of understanding at the top levels of government of the importance of our space program and the need to have both a quality program and stability of that program.

I'll use another analogy. If we treated the Air Force as we do the space program, we wouldn't have any flying aircraft. We would—we cannot decide every few years what we want the purpose of the space program to be. We have to have a societal-level agreement as to that purpose and then let our appointed officials carry it out. And it almost doesn't make any difference to me how they are appointed or what their term is. Thank you.

Mr. BRIDENSTINE. Thank you. Mr. Chairman, I yield back.

Chairman SMITH. Thank you, Mr. Bridenstine.

And the gentleman from Texas, Mr. Babin, is recognized for his questions.

Mr. BABIN. Yes, sir. Thank you, Mr. Chairman.

Great testimony, thank you. Thank you all.

Dr. Griffin, you testified that the most logical step beyond the ISS is an international partnership led by the United States to return to the moon, this time to stay. How does returning to the moon and maintaining a permanent presence there help us eventually send American astronauts to the surface of Mars?

Mr. GRIFFIN. Well, thank you, Dr. Babin. I love that question. I believe that if God had wanted us to go to Mars, he would have given us a moon to practice on.

Colonel Collins made the remark earlier—I'm not trying to quote her, but to the general effect that learning how to live on—in space and on another planetary surface would transfer directly to learning how to go to Mars, and I believe that to be the case.

As in—I'll summarize by saying, as an engineer, if you wanted me to say when we're ready to go to Mars, if you will, like the head of naval submarines certifying a submarine for sea trials, then I'll say you're ready to go to Mars when you can put a crew on the International Space Station for six months, and they have to live there without any further help from the ground. Then, they get

ferried to the moon and they live on the surface of the moon in 1/6 gravity for 13 months. And then you bring them back and you let them live on the space station again for six more months in zero G. and during all this time they get no additional help beyond that which was preprinted on the surface of the moon or on the station. So that ends up being a total of about a 26-month cycle for that crew.

When we can do that and the crew is still alive and healthy, then we're ready to go to Mars and not before.

Mr. BABIN. Excellent. Thank you very much.

And, Colonel Collins, you testified that program cancellation decisions made by bureaucracies behind closed doors and without input by the people are divisive, damaging, cowardly, and many times more expensive in the long run. I cannot agree more.

What do you recommend that we do as a nation to prevent these types of cancellation decisions and ensure consistency of purpose over many years and over many political administrations?

Ms. COLLINS. We as a country need to discuss these very, very important missions out in the open. They have got to be discussed—I don't believe this was discussed—in fact, I'm sure it wasn't because I was very shocked and very surprised when I learned that the budget was rolled out that first week in February of 2010 and there was a big fat zero in the Constellation program. I asked one of the top managers at NASA—in fact, I was up here on the NASA Advisory Council—did you know this was coming? And he said well, we thought we might have lost Ares I. We had no idea that we were going to lose the whole thing. I was just amazed that—does our government work this way? This can't possibly be true.

Mr. BABIN. It shouldn't.

Ms. COLLINS. So to answer your question, what do we—we have got to ensure the discussion takes place in the open and that—and this is the way good businesses need to be run. You've got to talk to the people that work all throughout the organization, people outside of the organization from academia, from industry. It is most certain that everyone will disagree on how we do it, but that's healthy. And then we make a decision by—I mean, you can vote or we can be autocratic about it, but it cannot be a surprise, so however you do that.

And I'd like to add one other thing to your previous question about going to Mars. It is very, very, very important that the life-support systems work, and the space station, this it—I know I'm saying the obvious here, but what we're doing on the space station is essential. But the moon and Mars are different places. You've got dust, you do have some gravity, it's just a different place. You have got to test your closed-loop life-support systems, whether it's in habitat, a spacecraft or in a spacesuit. A spacesuit is a—like a mini spacecraft.

Mr. BABIN. Right.

Ms. COLLINS. So I just wanted to add that to the previous question. Thank you.

Mr. BABIN. Okay. Thank you so very much, witnesses.

Mr. Chairman, I yield back.

Chairman SMITH. Thank you, Mr. Babin.

And the gentleman from Alabama, Mr. Brooks, is recognized for questions.

Mr. BROOKS. Thank you, Mr. Chairman. And witnesses, again, I apologize for being a little bit tardy, but I had a 9:30 House Foreign Affairs Committee hearing with Secretary of State John Kerry over the State Department budget, followed by Armed Services at 10:00 a.m. with General Breedlove on U.S.-European commands, so I hope you'll bear with me. I got here as quick as I could.

I do have a question for each of you. And, Dr. Griffin, if you could please lead off. Why do you believe—excuse me. What do you believe the proper role of commercial space could be in the context of a stable, long-term NASA strategic plan?

Mr. GRIFFIN. Well, as I pointed out in my testimony, the first commercial cargos for carriage to the International Space Station were signed under my tenure, so I'm a strong supporter of the utilization of commercial space purveyors in our strategic plans.

That said, I think we've maybe a bit drifted off the path. When I use the term commercial to describe an enterprise, I'm talking about an enterprise such as I've run in the past where you have to raise your own money, develop your own product, bring it to the market, and then you sell it for every dime that you can get. I'm not talking about enterprises where the government has to invest the lion's share of the money in order to earn the right to buy a ticket.

And if the public record is examined, I think that you'll see that in recent years in our so-called commercial space portfolio, that's what happened. The lion's share of the money has come from government. In fact, I'm not sure there's a share that the lion didn't have.

So these types of arrangements I would call private-public partnerships, and I'm not always certain that we're getting the best deal on the public side of those partnerships, and I think we need to look carefully at it.

The second thing that I would observe is if we have—if we were to be so fortunate as to have again a national strategic plan for what we want to do in space, it certainly should include as much contribution as commercial space providers can offer. But they need to offer what it is that the government wants to buy. It's not our purpose in government to figure out what our space program should look like so that commercial providers can sell what they want to sell. And again, I would say that the experience of recent years offers some guidelines in that regard. So I'll just leave it at that. Thank you, sir.

Mr. BROOKS. Colonel Collins or Ms. Chaplain, do you have anything to add?

Ms. CHAPLAIN. I'll just add that, you know, the government is usually the one to push technology and discovery, and in all those areas that's where the government's role should be. When you have lower-risk technology or something that's already proven that's needed, that is a good place to use pathfinder types of commercial efforts where they can prove themselves and even take over some kinds of operations.

If you look more broadly beyond NASA, commercial space is starting to play a bigger role in doing things like hosted payloads

for government, providing bandwidth for DOD, and even running ground operations. There's all good areas for them to be playing in.

Mr. BROOKS. Yes, ma'am.

Colonel Collins?

Ms. COLLINS. Sir, I'd like to just mention the space station as far as commercial space. I know this may sound like it's a crazy idea, but—okay. The space station, we know, is funded to 2024, and the United States has to decide are we going to find that out to maybe 2028 or do we stop funding in 2024 and put it into heavy lift or deep space? Having been in space, I believe that there will be a commercial interest in the space station. I can't really say timing-wise 2024, but there are plenty of tourists and people that have money that would love to go up in space and live on the space station. It is such an amazing, wonderful human experience. People would pay big money to do that, and if we could find a private company that'd be willing to take over the space station and sell it like a hotel, sell space up there like a hotel, we may be able to kind of wean ourselves off the space station and get NASA back into deep space, just a thought.

Mr. BROOKS. Well, what are we paying the Russians now? Somewhere in the neighborhood of 60 or \$70 million per ride?

Ms. COLLINS. Somewhere—

Mr. BROOKS. Do you think there's a market for the space station at that ticket price? Well, the Russians have sold one or two, haven't they?

Mr. GRIFFIN. If I could make a comment, I don't think we'll find out if there's a market until we try.

Mr. BROOKS. Okay.

Mr. GRIFFIN. I would echo Colonel Collins' comments about value—the longer-term value of the space station. I have to add, I think it's really shocking to be considering that after the multi-decade and multi-tens of billions of dollar investment in the space station that now we're talking about what date we're going to reenter it into the Indian Ocean. I cannot think of another example of a large laboratory investment or a large facility investment that the day it's completed we start figuring out when we're going to tear it down.

If the government cannot find suitable uses for a laboratory in space, then I would echo Colonel Collins' comment. Maybe we should consider turning it over to a private entity and seeing what they could sell space on the space station for.

Mr. BROOKS. Thank you for that interesting insight.

Chairman SMITH. Thank you, Mr. Brooks.

In the interest of balance and because he is such a diligent Member of this Committee, without objection, the gentleman from Colorado, Mr. Perlmutter, will be recognized for an additional 2 minutes.

Mr. PERLMUTTER. Thanks, Mr. Chair.

And my friends on the Financial Services Committee wonder where I've gone. I just said I've gone to the Science Committee, so that's what's happening here.

Ms. Chaplain, I'd like to ask you, because Dr. Griffin has used the comparisons of the Air Force and the Navy and, you know, building this and building that. From a GAO standpoint, I mean,

how can we have a multiyear—how does a multiyear kind of acquisition process work when no Congress combined the next Congress? How do you do that?

Ms. CHAPLAIN. So typically, you do commit over time to any program. Even NASA does that. The contracts work year-by-year. The multiyear authority allows you just to go beyond that first span of time, five years, and to commit to buying a lot more items upfront. That does tie the hands of Congress, but it doesn't tie funding so much because that's still done on the year-to-year basis. So you're just making a longer-term commitment.

The issue in taking this authority and applying it to NASA is it works better in a production environment. Even DOD, before it can employ a multiyear contract, has to demonstrate that there's stable design, stable requirements, that there's going to be substantial savings achieved from buying in bulk. Instead of six airplanes, for example, you're committing to 30.

So we have some questions in our head about how this could work in the NASA arena. Most NASA projects are just one-off satellites, for example, and the cost-plus arrangements that they use for that because they involve a lot of discovery, are appropriate.

Mr. PERLMUTTER. Well, see, I guess one of the things we've been talking about is a Mars mission, all right? And I—there's a lot of support for something like that, and we pick a date and, you know, we've had the scientists who say 2033 is when the planets line up in a way that makes it easier for us to get our astronauts there. So that's why I'm taking that date.

If we give—if we the Congress say to ourselves and to the President, you know, we want a date, and then we let NASA and its experts kind of say, okay, this is how we're going to do it, these are the building blocks that includes going back to the Moon and that this—I mean, they're the experts on this side. Is there—have you seen anything in your experience that gives us—we could do a multiyear acquisition or approach where we could dedicate money for the next 17 years?

Ms. CHAPLAIN. Usually, for long-term projects within DOD, money is dedicated up front. But again, if you're developing and researching a Joint Strike Fighter, all those contracts up until the point that you're ready to produce are sort of in that cost-plus range and they go year-to-year because you have a lot of unknowns and you kind of have to revisit things on a year-to-year basis. Once you enter the production phase, you're in a better situation to do fixed-price contracting that can actually go through many years.

So I don't know if what we have now would work ideally, the authorities now would work well for the Mars situation. If you committed everything up front, it would be an incredible amount of money that you would have to put aside to guarantee that it's all there for the 20-year effort.

Mr. PERLMUTTER. No, and I thank you for that. I mean, it's a big amount, there's no question, but we, you know, at least during my tenure here in the Congress since 2006, we've spent a lot in the Middle East. We've spent a lot to keep Wall Street from collapsing, you know, and it's been sort of bipartisan in nature in terms of those appropriations. So the country is a wealthy country; it's how

we prioritize things. We can do this. There's—from a money standpoint if we're prepared to make this a priority.

And that's why I'm prepared to listen, you know, to an approach like Chairman Culberson has of a way that might give both sides of the aisle some comforts going long term because we—this has to be long term. We have to think long term. We can't think just next year.

Ms. CHAPLAIN. And I would just add the bill talks about multiyear contracting. There are also options for multiyear funding and appropriations that work sometimes on the DOD side that wasn't mentioned in the bill, but there are some other mechanisms that could be explored on the appropriations side.

Mr. PERLMUTTER. Okay. Thank you. And I thank the Chair for giving me this extra time.

Chairman SMITH. Thank you, Mr. Perlmutter.

The gentleman from California, Mr. Rohrabacher, is recognized.

Mr. ROHRABACHER. Thank you very much. And I also apologize for being tardy today. I was at that meeting with Secretary Kerry, and I happen to believe that our space effort is actually as important as American foreign policy to our future, so I tried to run between these two.

I've been here 28 years, and of course Dr. Griffin and I worked together over these years, and I certainly—let me just be on the record that I certainly agree with your concept of making sure we go to the moon before we go on to Mars and learn a lot as we're doing that, getting back to the moon.

What I have seen, Mr. Chairman, is our biggest problem in having space—a rationale space program is with us. I mean, we just seem to try to—we prioritize projects and we spend money for projects that we can't do. And thus we—and then we end up defunding what we can do. And that's—it's irrational, and I understand, with all due respect to my friend and colleague who is so adamant about going to Mars, I have several of my friends who are that way, we're not ready to go to Mars right now. We don't even know—the technology's not there. But there is the technology and availability of doing things that we can actually accomplish right now. And if we want the respect of the American people, we're going to do it by making sure we get things done.

And having a long-term commitment that drains money away from the projects that we can do in order to accomplish something that we can't do now and maybe won't be able to do within our lifetime, that is not being responsible, and frankly, I think that's where the problem comes from. We continually try to finance projects that we are incapable of accomplishing at that moment. And of course you're going to have a high failure rate if you do that.

So I would hope that as we—and I—as I say, I agree with Dr. Griffin on his approach that we need to step by step—several of the things we could do, by the way, which we could do which may be totally unfunded if we just spend all our money on going to Mars is we have a space debris challenge. We're not going to be able to do anything in space unless we have some sort of space debris program. It'll have to be an international effort. But in the years

ahead, that's going to overwhelm us. It's already beginning to overwhelm us.

We don't have a global defense system set up so that if an asteroid—and I'll ask this of the panel. If that meteorite that skimmed the surface over in Russia a couple of years ago, instead of going—being in uninhabited areas would have hit a major city anywhere in the world and killed hundreds of thousands of people, do you think that that would have then changed the entire course and direction of our own space budget? Wouldn't that have been a factor that would have overwhelmed—and then all of these other programs that we've financed like long-term missions to Mars would just go by the wayside? So we need to take care of that issue, don't we? Don't we need to take care of space debris? Don't we need to take care of those things that we can get done and in the private sector we could leave things up like—by the way, refueling stations, et cetera?

There is one other lab, by the way, in terms of the space station. I remember, wasn't the space lab also a huge investment that we just allowed to come down as well?

Mr. GRIFFIN. That was Skylab, sir—

Mr. ROHRABACHER. Skylab, excuse me.

Mr. GRIFFIN. —and yes, we did. We have an unfortunate record of not preserving our capital assets in space.

Mr. ROHRABACHER. Right.

Mr. GRIFFIN. It reentered in 1979.

Mr. ROHRABACHER. Well, I would think that the problem of not being able to accomplish our missions is—can be found right here in the fact that our judgment has been to try to do things we can't do while defunding those things we can do. Thank you very much.

Chairman SMITH. Thank you, Mr. Rohrabacher.

The gentleman from Virginia, Mr. Beyer, is recognized for his questions.

Mr. BEYER. Yes, thank you, Mr. Chairman. And thank you all very much for being here.

Dr. Griffin, in his prepared statement this morning Representative Culberson stated “that over the years, a lack of clear mission has worn down morale at many centers.” And he talked, interestingly, about people saying, well, is our mission to go to asteroids or is it to go to the moon again or is it to go to Mars?

But I also find the assessment somewhat puzzling when you consider the findings from the annual survey by the nonpartisan Partnership for Public Service that consistently ranks NASA as the best place to work among federal agencies. And while the median overall index score for large agencies has shown a slight downward trend 2011 through 2015, NASA's score actually went up during the same period.

And according to the partnership, the biggest factor affecting employee satisfaction and commitment overall in the best places to work rank is related to effective leadership. How do you reconcile NASA being a great place to work with Representative Culberson's concern about a lack of morale?

Mr. GRIFFIN. I'm sorry. Was that for me or for Colonel Collins?

Mr. BEYER. Oh, either one, yes. Colonel, Doctor, Colonel Collins?

Ms. COLLINS. Well, I think that's a very good question because it depends on who you talk to. I can tell you, though, that when I was at NASA, morale was very high. We had space shuttle program, we were building a space station and supporting the space station with the knowledge that the long-term goal is going to Mars. I know that's very far out in the future. I sure hope I'm alive when people walk on the surface of Mars, but I'm pretty sure my kids are going to be here when we walk on Mars, and I think we're going to get there.

But to answer your question, you know, I think that would—that's not entirely clear to me. I know that when I did surveys like that, I gave NASA the highest ratings possible because I felt that the leadership within the astronaut office and flight crew operations and even at Johnson Space Center was outstanding. And I think that was the perception of my coworkers also.

Every organization has its cultural issues. I would have to say of all the places I've worked, NASA is the tops, no doubt.

Mr. BEYER. Let me follow up. Representative—

Ms. COLLINS. But—

Mr. BEYER. Oh, excuse me. Go ahead.

Ms. COLLINS. Okay. When the Constellation program was cancelled, what happened shortly after that was people thought, did I just lose my job? What am I going to do tomorrow? Do I go to work tomorrow? I think there was a very unstable period there, and I'm not even sure that the bosses knew what to tell their people. Just keep coming to work, just keep doing what you're doing, but when am I going to lose my job?

So I think that's a—that's really a tough question to answer. I can see both sides of the issue.

Mr. BEYER. Let me ask a follow-up. Representative Culberson also in his testimony talked about—I think it was 27 projects—major projects have been cancelled, \$20 billion that basically had to be written off, invested but then lost. If you had a ten-year Administrator who emerges from this new board, is it less likely that these projects would have had to be cancelled?

Ms. COLLINS. That remains to be seen. I do want to make a comment on the proposal for the ten-year Administrator. I think that the concept is good. I think it might be too long. In reality, if—when you start searching for someone who is willing to commit to ten years of a very, very difficult job, which is your—it may be hard to find somebody of all the qualified people out there that want to initially commit for ten years. And then how do you know that they'd be willing to stay that long? It's just a long period of time. If you went more with 5 or 6, I think your pool of qualified potentials out there would be bigger and you'd have more people willing to take on the very difficult job of NASA Administration.

Mr. BEYER. Okay. Thank you.

Ms. COLLINS. But I think it remains to be seen. On the surface, I would say yes.

Mr. BEYER. Okay.

Ms. COLLINS. Just based on what I have seen with over government agencies.

Mr. BEYER. Let me—one last question of Dr. Griffin. So the bill proposes a budget proposed by the management board in addition

to the one proposed by NASA and OMB and what we're working at here on the Hill. Do you have any concerns about a the Board proposing a detailed budget when they have neither the management responsibilities, nor the accountability for delivery and results?

Mr. GRIFFIN. Well, I do. I do have concerns about that. I had to—one of the key things for which I was responsible for when I was Administrator was preparing with all of my staff a detailed budget, and it was something that we paid close attention to because, of course, it had to go from us to the OMB, where we would have to defend it to the OMB, and then it would come from the President's budget submission to Congress and we would have to defend it to the Congress. And I didn't want anything in it that I didn't support and didn't agree with.

It would be, I think, very difficult as a practical matter to support that exercise and then to have a similar but in some ways different budget coming from an independent board. I would wonder where they would get their information. If their information came from NASA, as it almost must, then really how would it be different than the budget the Administrator prepares other than they have different priorities. But I can ask any group of people what your priorities are, and they're as, you know, likely to be different. So I would have concerns about that approach.

Mr. BEYER. Thank you. Thank you, Doctor.

Mr. GRIFFIN. But equally, sir, I must conclude by stating that anything which can be done to ameliorate and control the influence of the OMB on the process would be welcome. I mean, the OMB is a haven for largely unelected, un-appointed, not-very-well-qualified staff who seek to exercise a level of power and control in their area that their accomplishments have not earned.

Mr. BEYER. You're not doing anything to help OMB morale right now, Dr. Griffin, so—

Mr. GRIFFIN. You know, that's really too bad. So anything which can be done by the Congress to ensure stable budgeting of appropriate projects, I think, would be a good thing. I'm not sure that the Board-of-Directors approach is that method. Thank you.

Mr. BEYER. Thanks for your perspective.

Thank you, Mr. Chair.

Mr. BABIN. [Presiding] Yes, sir.

I now recognize the gentleman from Alabama, Mr. Palmer.

Mr. PALMER. Thank you, Mr. Chairman.

Dr. Griffin, we hear over and over again about a need for constancy of purpose at NASA and the detrimental impacts of shifting priorities, organizational conflicts, mixed signals from Congress, and I can go on and on. How much of this lack of purpose do you think can be changed through a reorganization such as the one outlined in the Space Leadership Preservation Act?

Mr. GRIFFIN. Well, sir, as we talked earlier, I think the Space Leadership Preservation Act might be one tool to achieve that constancy of purpose, but it's just a tool. If the Congress at large can codify into law a space policy for the United States that its citizens support and the space community supports and that we want to do as a society, that is the crucial step.

Mr. PALMER. You're saying we've got to work through the ideological differences Congress?

Mr. GRIFFIN. Yes. Yes, sir. And I will remind you, if that sounds a hopeless task, I was here.

Mr. PALMER. Well, if it were up to my colleague from Colorado and me, we could work this out fairly quickly.

Mr. GRIFFIN. But we did this in 2003 and '04 following the loss of Columbia, and for a two-year period, I myself participated in four hearings in both House and Senate, along with many, many other people, and these things were thrashed out, and we emerged from that period with a good plan.

Mr. PALMER. I come from an engineering background, and I believe the space program is fundamentally more engineering than science. Obviously, there's science and in engineering, I think anyone who's been involved in that field understands that you have to have clearly defined objectives. Otherwise, you'll never build to design. You'll—and you will spend an enormous amount of money and get nothing. And so I do think we've got to have that—a vision that we can design to, which, I guess, does the lack of continuity at NASA affect some programs more intensely than it does others?

Mr. GRIFFIN. I couldn't agree more with your comments, sir. I could not agree more. And the longer-term and larger the project is, the more that lack of consistency of purpose affects it. If I have a discovery program, a small satellite mission program to another planet that costs \$500 million and can be done in three or four or five years, then, no, such a program would not be much affected.

If we're talking about recreating a new heavy lift launch vehicle, as we are with the Space Launch System that Colonel Collins mentioned earlier today, well, that is a multiyear proposition and a multi-billion-dollar proposition, and it needs to be sustained or not done at all.

Mr. PALMER. I've actually visited the facility where that work is being done, and it needs to be completed because there's not a whole lot of use for it if we don't. And I think many of my colleagues here would agree with this, that we do need to allow NASA to define the vision with our oversight but get behind it. Otherwise, we're going to continue to waste an enormous amount of money.

Dr. Griffin, I'll ask you this question. There's an op-ed in Space News, Mary Lynne Dittmar of the Coalition for Deep Space Exploration touts the flexibility of the Space Launch System, which was just mentioned, which will be capable of launching a wide array of missions, given the lack of continuity, how important is it for NASA systems to be adaptable to changing priorities?

Mr. GRIFFIN. Well, it would be nice to say that NASA's systems and programs could be easily adapted to changing priorities. I don't think it's very realistic. It's one of those things that everyone would like but is pretty hard to do. When it takes five or six or seven or eight years to accomplish a great thing, if the priorities change in the meantime, you know, you're left hanging. And——

Mr. PALMER. That's where you run into all of the change orders and——

Mr. GRIFFIN. That's——

Mr. PALMER. —the run-up in cost and then everybody's frustrated.

Mr. GRIFFIN. Exactly, sir. It costs more money and you don't get the product out in the end. I thought Mary Lynne's op-ed was very well done. She's far more articulate than I am, and I was glad to see such an op-ed in Space News.

Mr. PALMER. Well, I had to go to another hearing earlier, but while I was here, I heard you talk about the overall vision for space and what it means for us and Colonel Collins' comment on this as well. And that was an inspired—in my opinion, an inspired view of America's role in space, and I commend you for it.

My time is expired. I yield back, Mr. Chairman.

Mr. BABIN. Yes, sir, Mr. Palmer.

I now recognize the gentleman from Illinois, Mr. Hultgren.

Mr. HULTGREN. Thank you, Chairman, and thank you all for being here.

First, I seek unanimous consent to enter into the record an article that was coauthored by former Commerce, Justice, Science Subcommittee Chairman Frank Wolf and Norm Augustine, who this Committee knows very well. So I'd ask unanimous consent for submission——

Mr. BABIN. Without objection, so ordered.

[The information follows:]

The referenced document was not provided at the time of printing.

Mr. HULTGREN. Thank you.

Again, I want to thank you all for being here, so grateful for your work. I especially want to just thank Colonel Collins. I really appreciate your service to our nation and the inspiration you are to young people, but especially to young women of incredible opportunities and how we need them to be involved in space and science and discovery. So thank you.

And, Dr. Griffin, so grateful for your service as Administrator, really I think a bright time and a time we can be proud of of your service there, so I want to thank you so much for that.

This is an important hearing, and as we continue to look for ways to bring long-term vision and stability for NASA, National Aeronautics and Space Administration. I think it's something we need to be looking at across our entire scientific ecosystem as well. As science becomes an increasingly collaborative and international enterprise, other countries are putting their stake in the ground to find a place with they will lead. America has traditionally led across the board. It is not the only measure, but one need only look at the list of Nobel Prizes per country. We are the number one, but other countries are catching up very quickly.

If we rest on our laurels, we may have a future where we have to send our kids overseas to get the best education in the world and to do groundbreaking research to get that next Nobel Prize.

One idea outlined by the article that I entered into the record, but the article written by Congressman Wolf and Mr. Augustine is for a dedicated fund for scientific research that we can actually put together 5-, 10-, or 25-year plans. As our witnesses should be able to attest, our researchers and scientists are walking on pins and needles just hoping that their project can stay on pace, on budget, and outside the ire of OMB bureaucrats or a disinterested Administration. When the President leaves or shifts around Administrators, researchers have to spend their time catching new people up just to let them know what we are doing.

A program can be cut or priorities can be shifted without the full picture. The cancellation of Constellation was a disaster. I think we all can see that now. It has been not just a setback, but it also hurts our standing in the world. I think Russia snickers when we need them to take our astronauts to the space station that our shuttle built.

Dr. Griffin, what are the first questions that we get from other nations when we come to them with an ambitious long-term project that will require all sides to deliver to see success? What response do we get back from them?

Mr. GRIFFIN. Well, in my time we were still working on trying to do two things. We were working on completing the International Space Station because only 1/3 of it was finished when the shuttle went down, and so the first questions I faced almost immediately after my confirmation hearing back in the spring of 2005 were from our partners. Are you really going to stick with this? Are you going to see it through?

And following the loss of Columbia, we knew that we were not going to be able to have as many shuttle flights as we had previously planned, so we had at that time to cut back somewhat our—what we called our utilization flights in order to prioritize as-

sembly. And I committed—with the backing of then-President Bush, I committed that the United States would finish the station. And the sighs of relief were palpable. So I'm answering your question by my experience is what they want to know is are you going to see it through?

Mr. HULTGREN. Yes.

Mr. GRIFFIN. When we asked them—the second thing we were doing—per our instructions from the White House Congress, the second thing we were doing was embarking on a plan for human lunar return. And the written words in the policy said that we would do it in company with our international partners, so it became my job to put that partnership together.

The first question they asked is, are you really serious? And at first they didn't really believe it. As several years went by, they did believe it, and by early 2009, they were fully in support of returning to the moon. And in the next year we cancelled. I had—I was of course gone from Washington by then, but I had phone calls from all over the world.

Eileen made the comment earlier that the NASA Advisory Council did not receive any information prior to the cancellation of Constellation, that it would happen. Well, you can take that and square it for our international partners who woke up on a Tuesday morning to find out that the lunar program they thought they were a part of was gone.

I know I'm overstaying my time and yours, but I must conclude this question with a story that I think is sad for what it conveys. In the spring of 2010 I happened to be down at Cape Canaveral and having dinner at one of my favorite restaurants down there over the years, and a waiter, an immigrant from Italy who knew me well, came over to my table and said, Dr. Griffin, he said, what is this I hear they're cancelling the moon program? And I said, yes, that's true. And in typical Italian fashion, he starts waving his arms and saying I came to this country because you were the people who can build space shuttles and build space stations and go to the moon, he said, and now you're not? He says what is it with these people? Do they not know what it means to be a superpower? And I will never forget that conversation. That is what people from other countries think of us when we start and stop. Thank you.

Mr. HULTGREN. Thank you. Well, I totally agree. My time is up, but really, we need to put our money where our mouth is. We need to follow through on our commitments. And so I appreciate it. Again, my time is up. I yield back, Chairman. Thank you.

Mr. BABIN. Yes, sir.

I now recognize the gentleman from Georgia, Mr. Loudermilk.

Mr. LOUDERMILK. Thank you, Mr. Chairman.

Dr. Griffin, I know during your tenure at NASA you put a lot of focus on international cooperation, but you were cautious about putting international partners on a critical path, especially from the lessons from the International Space Station program. What—I'm sorry. What recommendations would you have for the future Administrators regarding international cooperation?

Mr. GRIFFIN. Well, sir, the way that I would characterize that—and that's a superlative question. And when we talk about critical path, we have to understand what we mean. Certainly, our inter-

national partners in terms of our lunar program were—I'll use the quote on the critical path for a lunar base because the United States certainly wasn't going to build everything we needed for a human outpost on the moon, far from it.

When I say that it's a good idea to keep partners off the critical path—and that may apply as well internally to the country as externally—a given piece of hardware, a given mission support function should probably, as best you can, be confined to one entity. So we were going to build the heavy lift rocket. Maybe the habitat would be furnished by the European Space Agency. Maybe a laboratory would come from Japan, something like that. Maybe the power system would come from France, which is, you know, as you know, 80 percent nuclear in—domestically.

So my comments about critical path have I think in the past often been misinterpreted. When we're doing international programs, we need everybody's contribution. I don't want to build a car by having, you know, the tires come from one manufacturer and the engine from—I think you get my point.

Mr. LOUDERMILK. Right. Yes. I appreciate that. You know, growing up during the Apollo time period, NASA and those astronauts were an inspiration to me. And that—my life was surrounded by the idea that we were exploring the unknown, that we were doing something that a superpower does, that we were taking risks and we were beating the odds of things that people said that could not be done. There were more reasons that we could not go to the moon than there were that we could. But I think that helped define American exceptionalism is that we set our mind to do it and we did it. And I think that inspiration set us on a path to further greatness, and I know it inspired me. It inspired a lot of my schoolmates.

What can we do going forward so that our space exploration will have that type of impact on the generations that are following us? It seems—I know that there is a lack of inspiration, I think, in our education system because a lot of children are asking where are we going? What are we doing? What am I here for? At least during that time period of my life there was a destiny. We had a purpose.

And for Colonel or Dr. Griffin, anyone, will we ever see that time again?

Ms. COLLINS. Well, thank you for the question. I think that's great. And obviously, the mission we had—now, I was inspired by the Gemini astronauts, as well as the—

Mr. LOUDERMILK. Yes.

Ms. COLLINS. —Apollo astronauts. I wanted to be one of them as a young child, and it led me into the study of math and science and eventually becoming a pilot in the Air Force and it was—

Mr. LOUDERMILK. I was Air Force as well, so thank you.

Ms. COLLINS. Yes, and it was just seeing what can be done. I wanted to be part of it because to me it was just a great adventure.

And to answer your question, though, we need to teach our teachers because every astronaut cannot be in every classroom.

Mr. LOUDERMILK. Right.

Ms. COLLINS. Now, I learned about the space program from a magazine. There's not enough astronauts to get into all the classrooms. I wish there were, but the teachers need to have continuing

education because I think some of them are a little bit afraid to teach space because they think the kids might know more than they do. So some of them—they don't—they want an astronaut to be in the classroom, but otherwise, they don't want to talk about it, so education for the teachers so they can get pumped up, it doesn't have to be done by the U.S. Government. A lot of private entities, educational groups around the country teach teachers, and I think we need to do more of that because that'll get more young people involved not just in the space program but we're becoming, you know, so much more technical. We need kids in cyber, we need kids in engineering, energy, there's—it's everything. But you can tie it all to the space program.

Mr. LOUDERMILK. That's right. I mean, and as I go back and look at movies such as *The Right Stuff*, and the one Tom Hanks did, the series, it—what it emphasized to me was the ingenuity beyond just the engineering but the thinking outside the box, the development of the lunar landing module, how we broke every other design because we needed to make it lighter. Whoever thought of a pilot standing up?

But these are the types of things that we just broke the mold and decided we're going to do it our way, and that's the type of thing I think that we need to see again, something to inspire this next generation to move forward and take what—the hearing we had yesterday was the discovery of magnetic waves. Well, one of the questions was how is that going to be a practical application? Well, my sense, the guys who discovered it are not going to be the ones who will take it and make a practical application, but it's the next generation that will take that discovery and then match that to something.

I applaud you for what you're doing. I still admire those who have the courage to break the surly bonds of Earth and go and explore the great unknown. Thank you.

Mr. BABIN. Thank you, Mr. Loudermilk.

And I want to thank the witnesses. This is one of the best hearings I have attended since being a Member of Congress, a Member of this Committee.

And I want to thank the Members for their questions, and the record will remain open for two weeks for an additional—for additional written comments and written questions from any Members who desire to do so.

Without any more ado, this hearing is adjourned.

[Whereupon, at 12:13 p.m., the Committee was adjourned.]

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

*Responses by Dr. Michael Griffin***HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE****“The Space Leadership Preservation Act and the Need for Stability at NASA”**

Dr. Michael Griffin, Former Administrator, NASA

Questions submitted by Rep. Brian Babin, Chairman, Subcommittee on Space

1. Recently, the European Space Agency has expressed interest in creating a “moon village.” Do you think it is in the national interest to participate in this vision for a presence on the moon?
 - a. Would you please elaborate on some of the economic, scientific and strategic rationales for an outpost?
 - b. How can the United States serve as a leader in this endeavor?

I do not think it is in the interest of the United States merely to “participate” in the ESA-proposed “Moon Village” concept. *I think it is very strongly in the interest of the United States to be the leading partner in such a venture*, with of course due respect for the roles and contributions of the other member nations in the enterprise.

(a) The strategic rationale for U.S. leadership in opening up the Moon to human settlement follows from the inescapable fact that space is the new human frontier, the Moon is the nearest and most accessible destination on that frontier, and that leadership in the full span of global human affairs devolves to those who lead on the frontiers of their time. This has been true since the earliest human civilizations were established, and it will remain true in the future. Other nations and societies will inevitably explore and exploit space and the resources of the solar system; for the United States to abdicate leadership in that enterprise is to consign our heirs to second-rate status in future human affairs. We have allowed our leadership in space to lie fallow since the time of Apollo; it is past time to remedy the situation.

The economic benefit of establishing and growing a permanent lunar outpost will be manifold, but begins with the fact that such an outpost will have substantial and growing cargo logistics requirements. These requirements will provide and substantial and continuing base market for commercial space transportation well beyond what will ever be possible for the International Space Station. Beyond cargo transportation, there will be markets created for other commodities including power, communications, lunar-derived consumables, etc., any of which could be met by commercial entities. A U.S. government commitment to a lunar base, in company with our partners and allies, offers the most straightforward path to the development of a truly commercial space industry.

Concerning the scientific rationale, it has long been known that the lunar farside offers the best location in the solar system for a radiotelescope, while optical astronomy can equally be enabled by a network of telescopes operating without atmospheric

disturbances as on Earth. In the health science arena, and in consideration of our long-term desire to journey to Mars, the best place to study the effects of reduced (but not zero) gravity is in the 1/6th gravity environment of the lunar surface.

(b) The core capability for returning to, landing upon, and establishing a permanent base on the Moon is the re-development of the heavy-lift launch capability that the U.S. once possessed with the Saturn 5 launch vehicle of the Apollo era. Today's Space Launch System (SLS) is re-creating that capability. Almost equally critical is the development of the Orion crew vehicle, which enables astronauts to travel to lunar orbit and to return safely to the Earth. These will be the "must have" systems that allow and enable U.S. leadership in returning to, exploring, and exploiting our presence upon the Moon. As critical as these systems are, however, they are useless without the commitment of the United States, as a nation and a society, to lead in this enterprise. That commitment, rather than any technical capability or even the size of NASA budgets, has been the one element of space leadership which has been both most critical and most lacking.

The existing ISS International Agreements would provide a useful foundation for U.S. leadership in the effort to return to and remain on the Moon. However, it must be understood that those agreements were established some three decades in the past, when the capabilities of our partner nations were well less than our own. Today the gap, if indeed there is one, is much smaller; the lack of a U.S. imperative for true leadership in space has allowed others to approach and in some cases exceed our own level of spacefaring capability. Any agreements made with respect to the establishment of a permanent human outpost on the Moon must inevitably deal with this fact on the ground.

2. You testified that space is the human frontier, as important to our future as were the frontiers of land, sea, and air and that the consequences of getting it right or wrong are not immediate, but they are enormous when viewed in their proper historical context. You raised some very interesting existential questions. Can you please elaborate on the importance of space exploration and how you would recommend we bring these sorts of questions into the national space policy discussion?

The human future in space remains to be determined, and no one can do more than to make inferences concerning how that future might evolve. No one can know with any certainty what will actually transpire. In such situations, the best that can be done is to look to the past for a guide as to what the future might be. With that in mind, I think we can best understand why the exploration and development of the space frontier is important to our nation, by looking to our history and asking ourselves what our nation and society would look like if our predecessors had not pursued the initiatives that they did pursue on land, at sea, and in the air. The visions they pursued and the decisions they made have conferred upon us, their descendants, our present global supremacy.

But what if those leaders in earlier times had not pursued a vision in which the United States should be a continent-wide power? What if our vision, a century and more ago, had not encompassed the maritime supremacy that we take for granted today? What if the pioneers of aviation had not envisioned, and pursued, the technologies and systems that have given us, today, a civil and military aviation system of global reach and power?

The answers to these questions are obvious, and they reinforce how lucky we are that our ancestors got so many of these decisions right. Are we today to do less for our descendants?

The human future in space depends critically upon the decisions being made by our nation's leaders today. I believe that we would like to see a future in space which is dedicated to the rule of law, that values individual freedom, that preserves and extends the customs and mores of Western Civilization, and that offers to all the opportunities inherent in our free enterprise system. But the laws, values, customs, and opportunities in space will be determined not by those who stay home and watch, but by those who are on the scene, those who explore and settle the frontier. If we are to see the human future in space evolve as we would like, we must be there.

3. You testified that international cooperation in human space exploration is important and that a carefully crafted national space exploration policy will take into account the capabilities of potential international partners. Unfortunately, with the Asteroid Redirect Mission, the Administration has failed to heed this insight, crafting a program that is of little interest to the rest of the world. What lessons can be learned regarding international cooperation and strategic planning for NASA's human space exploration mission and how can these lessons be applied to long-term planning for NASA?

Partnership is a voluntary activity. Leadership is essential in such ventures, of course, but it must be collaborative, and especially so in regard to the goals which are to be pursued. The Vision for Space Exploration, enunciated in the period of strategic reexamination of our space program following the loss of Space Shuttle Columbia, offered goals which were readily and strongly embraced by our traditional partners. These included completing the ISS, building a new system for human space transportation to replace the Shuttle, and an international human return to the Moon. Through 2009, these were the goals to which we and our partners had "signed up".

When, suddenly, in 2010 these goals were set aside and replaced by an asteroid-focused plan which offered little or no possibility of international participation and, indeed, no near-term mission opportunities even for the United States, both domestic and international responses were understandably cool. The lessons are clear: plans and programs which make sense, and which are discussed and agreed upon between and among the partners before announcing them publicly, will be embraced. Other behaviors are not likely to be rewarded, with the result that the so-called "leader" may look back to find that there are no followers.

4. During your tenure at NASA you attempted to engage early and often with international partners, but were cautious about putting them on the "critical path" because of lessons learned from the International Space Station program. Do you have any recommendations for the next administration regarding international cooperation?

The discussion about a programmatic "critical path" is often overly simplistic, and so I think it might be useful to be clear in regard to how, in my view, partnerships in large scale space ventures should be constructed, as well as on what practices should be avoided.

If the term "critical path" is taken too literally, it precludes the involvement of an international partner in any activity which has any real value! Clearly, we do not want to do this. As I pointed out on many occasions during my tenure as Administrator, and after, the ISS would be a rather limited facility without the contributions of our partners. The Canadian manipulator arms, the European Columbus Laboratory, and the Japanese Experiment Module furnish a major portion of the overall operational and scientific capability of the ISS laboratory. True, the U.S. also provided a laboratory, and of course provides the ISS engineering backbone with the systems for power, propulsion, thermal control, communication and data handling, attitude control which are necessary for the facility to function. But the ISS as a laboratory facility would be of minimal value without our partners' contributions. In this sense, they were and are fully in the "critical path".

However, the ISS would obviously continue to function if, say, any individual laboratory had failed to arrive, or were to be removed. Thus, in this sense no single partner was in the "critical path" for ISS completion and operation. I regarded this as an important feature in the original program plan, given that the U.S. originated the program and provided the vast majority of the funding and logistics support to enable its success.

Thus, as illustrated by the above examples, there are actually two types of "critical path" which were part of the ISS program. I strongly support the former and strongly oppose the latter.

Another very positive aspect of the ISS collaboration framework is that, irrespective of the importance of a given partner contribution, all such contributions were at what I have called "the module level". That is, a given laboratory or subsystem (such as the U.S. solar arrays or the Canadian manipulator arms) was furnished as a completed unit by each partner. Partners were not involved in the design and construction of each other's modules, yet the sum of all contributions provided the facility we have in orbit today. This practice simplified the interfaces and management structure, and indeed made ultimate success possible, in my opinion.

In contrast to these "best practices" for U.S.-led partnerships, we have the troubling situation of crew transportation to ISS. By retiring the Space Shuttle prior to the deployment of a follow-on NASA-developed crew transportation system, and worse, by cancelling the development of such a system in favor of sole reliance on so-called "commercial" systems, we have placed our nation in a position of complete dependence

on Russia for transportation of our and our partners' astronauts to ISS. This is a logistically fragile and geopolitically unwise arrangement; indeed, I have on numerous occasions characterized it as "unseemly" for a great nation. I stand by this opinion. I would hope that these lessons from ISS would inform our decisions when, as we surely must, we decide to return to the Moon.

5. NASA has performed numerous launch vehicle architecture trade studies for deep space exploration, including Constellation, the Augustine Blue ribbon panel review, and the final design process and options that led to need for a super-heavy exploration launch vehicle, similar to the SLS configuration. What opportunities would SLS' capabilities open up with our international partners on human and science missions? Would this new launch capability provide the U.S. with a new tool for international cooperation on various projects?

Given my comments in response to QFR #4, above, I believe it is clear that I favor a U.S.-led international partnership to return to the Moon and establish a base as the best next step for the U.S. civil space program. The SLS is critical to the efficient execution of such a program, as well as to virtually any other space enterprise beyond low-Earth orbit (LEO). With this critical enabling capability that the U.S. can provide, and that at present only the U.S. can provide, we can and should assume a leadership role in the exploration and exploitation of the Moon and cislunar space, while also preparing for future expeditions to Mars. Beyond the critical role of facilitating beyond-LEO human missions, there is the role that a heavy-lift launcher can play in lofting large, flagship-class robotic science missions to the outer planets and their own moons, including Jupiter's Europa and Saturn's Titan. Almost by itself, the capability inherent to the SLS makes the U.S. a leader in space exploration. The will to use it to enable interesting, exciting, and challenging programs would complete the task.

6. Orion is being built to fly deeper into space than Apollo and return at higher speeds. It carries an advanced life support system that enables crews to exercise, provides radiation protection and can go to Mars with the addition of a deep space habitat. Given the capabilities of the vehicle and the lifting power of the SLS, what missions can you envision that would advance human exploration of our solar system while opening the door to human exploration-enabled science?

In addition to the plans for lunar return that I outlined above, the combination of SLS and Orion, together with a new deep-space habitat, would enable a mission to the moons of Mars within a decade. Exploration-enabled science missions could include future servicing missions to the James Webb Space Telescope, just as were performed in the past for the Hubble Space Telescope. Deployment of a large radiotelescope on the lunar farside would be a truly exciting scientific mission that essentially requires human

presence to complete. I believe that a query to the scientific community would result in many more interesting opportunities to combine missions human exploration and scientific discovery, given the completion of SLS and Orion.

7. In just two years, the United States will have the capability to return to the Moon with the SLS and Orion for the first time in more than 40 years and, for the first time ever, go deeper into space; providing a historic opportunity for American leadership in exploration. Do you believe that the next administration and Congress should stay the course on NASA's exploration system development to prevent another disruption – especially now that we are so close to having this exploration capability?
 - a. Why is stability so important in these programs?

I am sure that, given my responses above, it is clear that I absolutely do favor bringing these programs to completion. The importance of stability in goals and programs is critical. As we have seen in the recent past, when we continually re-examine what it is that we are trying to accomplish, when we continually churn the funding profile, when we place political impediments in the path of engineering developments, we waste money, consume time, demotivate those who possess our nation's intellectual capital, and squander our international leadership.

8. A new administration will be in place in about a year. Would you please address the challenge of maintaining continuity for NASA's human exploration program, particularly during Administration changes? And what recommendations do you have to address this issue?

As I stressed in my oral and written testimony and in my response to QFR #7, above, I believe that continued U.S. leadership on the space frontier is a crucial matter for our society. I can find no example of a nation which, having abandoned the frontiers of its time, continues as a leader among nations. Such leadership, or the lack thereof, has profound strategic geopolitical, economic, and scientific consequences, and I therefore consider it to be in the first rank of issues confronting our nation as we plan for the future. But one characteristic of strategic enterprises – and space enterprises are no exception – is that they do not fit conveniently within the 2, 4, and 6 year electoral timeframes of our democracy. Their importance transcends individual elections and the leaders selected through those elections. Certainly we must continually examine our programs and our intentions; certainly we must be prepared to change course when the environment or circumstances so dictate. But we must understand that such course changes carry a cost, and that we should demand clear evidence of a gain to be had that is worthy of the cost. The wholesale upending of the

plan which was in place at the beginning of 2009, a plan with clear bi-partisan Congressional support, widespread acceptance by the space community, and enthusiastic international support, should not have happened. It did not have to happen. It should not have been allowed by the Congress to go forward. And, for the future, once we are back on track, the Congress must embrace its role as the keeper of stability for our nation's space program. This matter is too important to be left to the ego of each new president and their callow, unqualified, unelected appointees.

**HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE**

“The Space Leadership Preservation Act and the Need for Stability at NASA”

Dr. Michael Griffin, Former Administrator, NASA

Questions submitted by Rep. Eddie Bernice Johnson, Ranking Member, Committee on Science,
Space, and Technology

1. The Aerospace Safety Advisory Panel indicated in its 2014 Annual Report that clarity of purpose and goal was not enough; that equally or possibly more important is a constancy of purpose. ASAP defined constancy of purpose as “*a steadfastness in pursuing the articulated goals that does not waver with time*”. How should such constancy of purpose be developed and maintained? What does Congress need to do to maintain such constancy of purpose?

I could not agree more with the ASAP on this matter. And, as a nation, we have in the past demonstrated nearly every aspect of that which is necessary to obtain the “steadfastness” that they and I believe to be important. Indeed, as I have testified, the NASA Authorization Acts of 2005 and 2008, passed after a lengthy period of deliberation in the wake of the loss of Space Shuttle *Columbia*, fully exemplified the kind of thoughtful, long-term, strategic goals which I believe are essential to a healthy, vibrant, forward-looking space program. The administration of that time had done its part in proposing such a plan, and the Congresses of that time had done their part in shaping the administration’s proposal, embodying it in legislation, and ratifying it through a change in partisan control of Congress. The events of that time, in the five years following the trauma of *Columbia*, could hardly have been better orchestrated.

What was missing, and this is where I think future Congresses can derive a useful message, was follow-through after the change of presidential administration in 2009. The new administration behaved as if the loss of *Columbia* had never happened, as if no thought had been given to space strategy after that loss, as if no deliberation had ever taken place in the space community and in Congress, as if no legislation had ever been enacted, as if no international partnerships had ever existed. Indeed, they behaved as if our nation’s space strategy was an empty field, awaiting the benefit of their intellectual contributions. The Congress did not have to allow this behavior, and should not have allowed it. The long-held understanding in our nation’s capital is that while presidents propose, Congress disposes. For my part, and had this dictum held sway in 2010 and later, we would not have needed this hearing.

2. With regards to constancy of purpose and the need for stability, H.R. 2093 does not specify how an Administration’s strategy for a future space exploration program is to be

reconciled with whatever vision the Board of Directors generates every four years. What are the potential implications of two, possibly competing, exploration visions?

As I indicated during the hearing, I do not particularly favor this approach. Unless each new administration is to abdicate its views on civil space strategy to this Board of Directors, there will not be a “potential” for competing visions; the competition will be actual, and it is unlikely to be helpful. I personally believe that our present and customary approach, *if we would adhere to it*, serves best. By this I mean the following: enabling authorization and appropriations law for NASA exists. It does not vanish upon the election of a new Congress and a new administration. Certainly a new administration can submit proposals to Congress in consideration of how the existing strategy should change, and each Congress can deliberate on such proposals, enacting such provisions as they find appropriate. But in the end, the enacted law of the land comprises the civil space strategy that NASA is expected to implement on behalf of the nation. The role of any putative “Board of Directors” in this process is not at all clear, and is unlikely to be helpful.

3. How challenging would it be for a Board of Directors that meets only on a quarterly basis to dive deeply enough into NASA-wide operations to make informed budget tradeoffs and allocations throughout the agency? Would you see the potential for duplication of efforts with the agency’s own fiscal year budgeting formulation process?

From personal experience, I would offer that the preparation of and advocacy for the budget of any federal agency, certainly including NASA, is a full-time effort for a substantial number of staff members, and a major priority for the head of that agency. It is not conceivable to me that any external body, unless it is itself employed on a full-time basis, could carry out the planning and preparation of the agency’s budget. If such a body were to be created, then it would indeed inevitably be in conflict with those internal to the agency and whose job would be indistinguishable from that of the external body. Where they agreed, there would be duplication. Where they disagreed, there would be conflict, and the only place that conflict could be resolved would again be in the Congress – exactly as it is today. I do not see how removing budget preparation and advocacy from NASA, or from any federal executive agency, solves any problem. At most it would seem to move the problem from one location to another within the federal structure.

4. In your view, are there any potential unintended negative consequences of the provisions in H.R. 2093 that we need to guard against?

In addition to the negative consequences implied by the answers to QFR #2 and #3, above, I would offer that a fixed term for the NASA Administrator is useful only if substantially shorter than ten years. Very few qualified people are in a position to make a ten-year commitment to such a post. For those who are qualified, a salary reduction to the levels customary in government service is almost certainly required; many people

who could bear this for four or five years could not do it for ten years. I do not believe we want to restrict the applicants for NASA Administrator only to those who are independently wealthy.

Further, with a lengthy term that is designed to mitigate the influence of any individual president upon the position, also comes the fact that those same presidents will have less interest in NASA and the space program. This is not the proper goal; we want the president to be interested in the space program; we want that program to be robust, vibrant, forward-looking, challenging, and exciting. This goal is best attained if all parties are fully involved, including not least the president and the key Congressional oversight committees. The events of 2009 and 2010, accompanying the change of administration, were greatly damaging to the space program, possibly more so in retrospect than could have been appreciated at the time. They did not have to happen then, and do not have to happen again, if we can recall and implement the proper role of the Congress in protecting our space program from the excesses of untrammelled executive overreach. That is the problem, and that is the problem that should be addressed. But, in my opinion, the way to address it is not to attempt to isolate the president from the discussion.

*Responses by Colonel Eileen Collins**"The Space Leadership Preservation Act and the Need for Stability at NASA"*

Colonel Eileen M. Collins, USAF, Ret.; Commander, STS-93 and 114, Pilot, STS-63 and 84; and former Chair, Subcommittee on Space Operations, NASA Advisory Council:

Answers to questions submitted by:

Rep. Brian Babin, Chairman, Subcommittee on Space:

1. What were the consequences of the policy change in 2010? First, and most important, a setback in human spaceflight. Although President Obama later added the Orion program back into the budget (April 2010) after cancelling Constellation (Feb 2010), and the Congress added the heavy lift booster with the 2010 Authorization (Oct 2010), the delay was a setback in both overall cost and time. Second: the people working human spaceflight lose motivation, momentum, and energy when the country's leadership puts the human spaceflight mission in such a low priority. Third, young people who are planning to choose a career in human spaceflight may change direction or change careers to something more stable.
What should be done to prevent this from happening again? I believe we found ourselves in this situation due to a decision-making style in the executive branch. The perspective of many in the industry was: How did this happen? Why did the annual budget have a zero in the Constellation program? Right or wrong, this was a surprise to us, despite the fact there was a study (Augustine) stating the program was over budget. Most people thought NASA would be given a chance to revamp the program and get back on track. But we instead of fixing the problem, it was cancelled altogether. I believe NASA should have been given some options: for example, cancel the portions of the program causing the issues (ex: Ares 1 only?), give NASA a warning to get the program below its cost target, or ask NASA for some options. The Space Leadership and Preservation Act is a step in the right direction. But another option is in the Executive Branch: In the late 1980's and early 1990's there was a National Space Council which advised the President on space policy. They were known, respected individuals who could access other leaders/strategists in the industry for the best ideas/options of space strategy, then advise the President in an open/transparent way. A similar body could ensure a more stable and united space policy.
2. I believe the Executive Branch should consider a National Space Council to advise the President on space policy/strategy. A Council should have individual advisors with backgrounds that cover the various space disciplines. Something like this could have prevented an abrupt surprise cancellation of Constellation. If Constellation cancellation was the right decision, at least it would have been vetted in a more public way, so stakeholders would realize the issues and raise awareness of the problems. I have no problems with the Augustine Report; it was very well researched. My concern was the method in which the Constellation program was cancelled.
3. If the US ceded lunar space to China, there will be long-term impacts to the US. This is a national security issue.
 - a. Yes, if we continue on the road we are currently on. But it does not have to be this way.
 - b. Yes, see c. below.

- c. Countries that are strong and remain strong are countries that explore. Countries that explore are leaders: they innovate, discover, and invent. See history as a guide. For example, Spain and Great Britain exploring the “new world”, Lewis and Clark expedition, William Seward’s purchase of Alaska for the US in 1867, etc. The value of US leadership in space goes further: National security is tied to our space program. For example, when the US first put a man on the moon in 1969, it is notable that we did not “claim” any part of the moon as ours. We abided by the “Outer Space Treaty” we had signed in 1967. We left a plaque that said “We came in peace for all mankind”. I am not so sure certain countries would be as humble in their exploration of other lands. For example, we see China creating and developing islands in the South China Sea and creating fear in nearby countries. Why are they doing this? Why would their interest in the moon be any less provocative? If some critics say the moon is a dead place of no strategic value, we can remind them of “Seward’s Icebox”. Today, we see the great value of Alaska as a state, something that many did not see in 1867.
 - d. NASA-led and NASA-run human space flight is important for our country’s leadership in “deep space” and the more inherently risky missions. Once NASA has led in a certain area (ex: low Earth orbit), and the risk has been minimized to the point that commercial firms are willing to pick up the missions, then NASA can turn over those missions to private companies. NASA should focus on deep space exploration and missions that private firms are not yet willing to risk. I am very comfortable with the strategy NASA is currently executing.
4. This is a very tough question: Here is how I interpret it: Should we stay with the current strategy of visiting an asteroid, moving it to cis-lunar space, then sending astronauts to explore it.... OR, change course and go back to the moon plan from the Bush administration (pre 2010). I originally believed the moon option was the right way to go. We all agree that Mars exploration by astronauts is the long-term goal. As an astronaut, I certainly would want to see all the hardware tested on the surface of the moon (only about 3 days from Earth) before we risked using it on Mars (a minimum of 6 month trip). But... if I was making the decision today: since it is now 2016, and so much preparation has been put into the asteroid option, I would stay the course. There are important technical developments in the asteroid mission. I do not believe we need a fully developed moon base before manned Mars missions, but we should still test selected hardware on the moon without unnecessarily delaying Mars exploration. Regardless, any decision like this MUST be made with a recommendation from NASA who also uses the advice of the NASA Advisory Council. I strongly urge our national leaders to work with NASA before making these drastic decisions.

Answers to questions submitted by:

Rep. Eddie Bernice Johnson

- 1. Constancy of purpose: I agree with the ASAP that “constancy of purpose” is essential to a healthy and stable space program. But it is not the primary concern. I believe safety overrides it, and sometimes a strategic change will be needed if it is discovered there are safety issues in

any new development effort. For example, I believe much of the hardware to be used in future Mars missions will need to be tested on the surface of the moon. NASA probably does not need a fully developed lunar base before Mars exploration by humans. But NASA engineers will know what specific hardware will need to be tested on the moon's surface.

I think "constancy of purpose" can be added to NASA's strategic plan or statement of its principles of exploration. It should be specifically called out in NASA's detailed strategic plan. How can Congress help? Congress should stay in touch with NASA leadership as well as have official communication channels to key leaders at NASA. This is not to meddle in NASA's daily affairs, but to insure feedback to our elected leaders. Congress should communicate with NASA leadership on a regular basis (I think that is being done), to receive feedback on how human spaceflight is staying on course, but the proposed Board of Directors would be helpful in this area.

2. I believe the NASA Advisory Council plays a critical role in advising the NASA Administrator. Having served from 2007-2011, I have observed the NASA Administrator come to every meeting, give a status and most importantly carry on a dialogue with the NAC members. The NAC is not a mandatory body; it serves at the discretion of the NASA Administrator. NASA has not always taken our advice, but they certainly considered it.
 - a. The NAC advises the NASA Administrator. With that in mind, I understand the proposed Board of Directors would advise Congress. This would be an entirely different role. Therefore, I believe the NAC will still play a meaningful role. My only concern would be the workload on NASA: There was much preparation by NASA whenever the NAC met. I was concerned we did not detract the employees too much from their daily work and I reminded them that although we are advising the Administrator, we also were hopefully giving them ideas on how they could improve their work. One possible idea would be to schedule the Board of Directors to attend NAC meetings. This would help everyone with consistency, build relationships between members, and minimize workload for NASA briefers.
 - b. I believe the NAC and the Board of Directors (should it be approved) should have similar functions with a major exception: the NAC advises the NASA Administrator, whereas the Board would advise Congress. The differences will flow from that distinction. Yes, there should still be closed meetings, if the law allows, only for personal or administrative topics. Any policy topics should be open to the public. Same as the NAC. I believe FY budget proposals should be open to the public.
3. Unintended negative consequences of HR 2093: First, a very long term for the NASA Administrator is not necessarily a plus. I think it would discourage some highly qualified people. Instead, I believe the outgoing NASA Administrator needs to make recommendations for his replacement: not just names, but qualifications, personal qualities, policy, opinions, and philosophies. Second: The Board of Directors could potentially have members who have a personal agenda. Guard against this by using a vetting process prior to naming members. The Board members also should have a strict limit on # of years they can serve. Three years, or five

years, with no renewal, is a good place to start discussing. Third: I like the idea of the Board presenting (potential NASA Administrator) names to the President, but I don't think the list should be mandatory for the President. The President should be able to pick whomever he/she believes is best qualified. The Board can certainly speed up the process, which in the past has taken way too long. Finally, I am concerned the Board may be taking work away from NASA that is really NASA's responsibility. For example, NASA should be working on their budget. If too much work is given to the Board, NASA could potentially start missing critical items. NASA has the technical experts and they need to retain the responsibility for their own work. I am also concerned about the workload generated in reference to the annual reports. Reports are important when needed but there can be too many. Although there are things in HR 2093 that "go too far" in my opinion, I still believe it is important for Congress to have someone advising them on space policy. (It's also important for the President to have his advisors, which is why I mentioned the National Space Council of the Executive Branch in the late 1980s and early 1990s).

Responses by Ms. Cristina Chaplain

Questions from Rep. Brian Babin, Chairman, Subcommittee on Space

1. **Year-after-year, the President signs an Appropriations Act that funds a portfolio of programs at NASA in one fashion, only to propose drastic changes only weeks later in the budget request. What impact does this have on NASA program managers' ability to meet cost, schedule, and performance baselines for major programs such as the Space Launch System and Orion?**

The President's budget requests are consistent with the planned funding for the Space Launch System (SLS) and Orion programs to meet their respective Agency Baseline Commitment, not the internal goals that the programs are working towards. The Congress has funded the Space Launch System and Orion programs at a level above the Presidents annual budget requests for several years, which has allowed the programs to continue to pursue internal schedule goals. Should the President continue to submit budget requests that do not align with the internal goals, and Congress decides to not add funding above those requests, then the programs may encounter challenges encountering internal cost and schedule goals. The effect on whether they could meet the agency baseline commitment under this scenario is not known at this time.

2. **In October 2015, NASA released its *Journey to Mars* - criticized by some in the media as a "Journey to No Where." You testified that NASA's *Journey to Mars* does not provide additional details on future exploration missions making it "difficult to understand NASA's vision for what type and how many missions it will take to get to Mars" and that without this information "decision makers do not have visibility into how NASA expects to develop, operate, and sustain a capability over the long term." What is your recommendation for NASA to address this deficiency?**

NASA should undertake longer-term mission planning—beyond Exploration Mission-2, the first manned flight of Orion and SLS—that includes cost and schedule estimates for those plans and provide that information to the Congress so that decision makers understand the agency's plans for its human exploration programs. To address this issue, we have previously recommended that NASA should (1) forecast a cost estimate range—including life-cycle costs—with minimum and maximum boundaries when the agency cannot fully specify costs due to a lack of well-defined missions or flight manifests; (2) identify a range of possible missions for each future Space Launch System (SLS) variant that includes cost and schedule estimates and plans for how those possible missions would fit within NASA's funding profile—this could also be applied to Orion variants and future hardware such as landers or habitats.

3. **While you noted that NASA's overall cost performance has improved as a whole, you have pointed out that there have been significant cost and schedule problems on individual projects. How many major projects have experienced significant cost and schedule growth and been re-baselined over the past several years?**
 - a. **What were some of the reasons these programs ran into problems?**
 - b. **Are there any programs that are at risk of experiencing similar problems?**

Over the last 9 years, eight projects have experienced significant cost and schedule growth and been rebaselined, including three projects in the current portfolio—Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2), James Webb Space Telescope (JWST), and Space Network Ground Segment Sustainment (SGSS). These projects experienced significant cost and schedule growth due to factors such as relying on overly optimistic contractor estimates and underestimating risks when developing the project's baseline. We found projects most often rebaseline between their critical design and system integration reviews. Nine projects are in that phase of development in 2016, including the Orion Multi-Purpose Crew Vehicle and Space Launch System, which have significant development risks.

4. In your statement, you mentioned the OSIRIS-REx project as one that has performed well. In your prior work, have you identified any other projects that have been well managed? Do you have any observations on what made those projects successful?

In general, projects that perform well develop and execute a knowledge-based business case, which can provide early recognition of challenges and place projects in a better position to succeed. In its simplest form, a knowledge-based business case is evidence that (1) the customer's needs are valid and can best be met with the chosen concept and that (2) the chosen concept can be developed and produced within existing resources—that is, proven technologies, design knowledge, adequate funding, adequate time, and adequate workforce to deliver the product when needed. There are also project specific factors that contribute to projects meeting their cost, schedule, and performance goals. The Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx) asteroid sampling mission attributed its \$78 million decrease in development cost to several factors, including a mature mission concept, or business case, and rigorous risk management process. In another case, the development cost for the Mars Atmosphere and Volatile Evolution Mission (MAVEN) was \$35 million lower than the project's baseline as a result of efficiencies the project achieved in completing the work and lower labor costs.

5. NASA acquisition management has been on GAO's High Risk since 1990. What are the main reasons GAO considers this a high risk area? Has NASA made any progress addressing those factors? What key actions must NASA take to get off GAO's High Risk List?

We designated NASA acquisition management as high risk in view of NASA's history of persistent cost growth and schedule slippage in the majority of its major projects. Our work has identified a number of causal factors, including antiquated financial management systems, poor cost estimating, and underestimating risks associated with the development of its major systems. NASA's senior leadership is committed to improving overall acquisition outcomes and has taken several steps to address high risk areas. For example, in 2007, NASA developed a comprehensive plan to address systematic weaknesses related to how it manages its acquisitions. The plan specifically sought to strengthen program/project management, increase accuracy in cost estimating, facilitate monitoring of contractor cost performance, improve agency-wide business processes, and improve financial management. The plan identified specific actions to be taken in each area and established points of accountability and metrics to assess progress. In 2015, we reported that NASA had implemented key components of the agency's action plan including instituting new tools aimed at providing increased insight into project performance, such as the collection of earned value management data—a tool designed to help project managers monitor risks—and the Joint Cost and Schedule Confidence Level—a process which assigns a confidence level, or likelihood, of a project meeting its cost and schedule estimates. Further, NASA has established metrics to more consistently measure a project's design progress and, in 2014, we found that most major projects in the portfolio were tracking and reporting those metrics.

While NASA has taken these steps, we have also found that the agency still faces significant challenges in managing and overseeing its most expensive and complex projects. More specifically, we have identified instances where the agency has either underestimated the risks and potential impacts; not reacted quickly enough to risks when they worsen; or resisted independent assessments of risk in light of changing conditions. In addition, while NASA has implemented tools in recent years to provide better insight into and oversight of its acquisition projects, the agency has not consistently applied training for and implementation of those tools. In some instances, the reason may be a lack of agency expertise or guidance in how to apply the tools, but in others adherence to tools has not been consistent. As such, more can be done particularly with respect to anticipating and mitigating risks, implementing management tools, and forecasting costs for its largest projects. Areas that will be critical to improving NASA's acquisition outcomes include ensuring that adequate and ongoing assessments of risks for larger projects are conducted, that improvements to its acquisition policies are implemented consistently agency-wide, that projects' Joint Cost and Schedule Confidence Levels are updated regularly and consistently across the portfolio, and that long-term human spaceflight projects' costs are understood. Specifically, long-term cost estimates for the Space Launch System and Orion projects, which currently have estimates through

only the first test flight, would provide decision makers with an informed understanding of the agency's plans going forward.

Questions from Rep. Eddie Bernice Johnson, Ranking Member, Committee on Science, Space, and Technology

1. Rep. Culberson showed a chart at the hearing to illustrate his claim that in the past 20 years, 27 NASA human space flight and related research and development programs have been cancelled resulting in over \$20 billion wasted on uncompleted programs. This is basically the same chart he and Rep. Frank Wolf used as an illustration during the press conference to announce the bill during the last Congress.
 - a. Did these cancellations occur independent of who was in the White House and independent of the length of term of the sitting Administration?
 - b. Were there technical or cost factors involved that led to the cancellations? If so, can you provide some specific examples?

We have not performed an analysis of all the NASA human spaceflight and related research and development programs cancelled in the past 20 years, but we have reported on challenges that faced the Constellation program prior to its cancellation in 2010. In September 2009, we reported that the Constellation program was struggling to develop a solid business case—including firm requirements, mature technologies, a knowledge-based acquisition strategy, a realistic cost estimate, and sufficient funding and time—needed to justify moving the program forward into the implementation phase. Gaps in the Constellation program business case at the time included (1) significant technical and design challenges for the Orion and Ares I vehicles—such as limiting vibration during launch, eliminating the risk of hitting the launch tower during lift off, and reducing the mass of the Orion vehicle—that represented considerable hurdles that had to be overcome in order to meet safety and performance requirements, and (2) a poorly phased funding plan that ran the risk of funding shortfalls in fiscal years 2009 through 2012 resulted in planned work not being completed to support schedules and milestones. This approach limited NASA's ability to mitigate technical risks early in development. The Constellation program was cancelled by the President in fiscal year 2010 after an independent commission concluded that Constellation faced challenges to achieve its stated goals of returning humans to the Moon by 2020. GAO reviewed some of the earlier efforts to replace the shuttle such as the Space Launch Initiative and the X-33/X-44 programs and identified numerous weaknesses such as difficulties in setting requirements and managing contractors. But we did not tie these problems to decisions to cancel.

2. In your prepared statement, you indicate that while multiyear procurement contracts, which are called for in H.R. 2093, can provide stability for contractors, "they also can reduce Congress's and NASA's flexibility in making changes to programs and budgets unless the government is willing to pay the cancellation fees associated to do so." Are you saying that changes in multiyear procurements require termination and ensuing cancellation costs? Can you elaborate on the nature of these cancellation fees and the magnitude of potential dollar impacts?

Multi-year contracts under Federal Acquisition Regulation (FAR) Subpart 17.1 allow the government to contract for the purchase of known requirements for more than 1, but no more than 5 years. If, after award, the government reduces its requirements (i.e. quantities) or wants to renegotiate terms on a multi-year contract, there would likely be a cost to doing so. The magnitude of these costs may be subject to negotiation. In addition, if sufficient funding is not available for the continuation of a DOD, NASA, or Coast Guard multi-year contract, the FAR states the contract shall be canceled or terminated. Cancellation dates are specified in the contract and occur every year. If cancellation occurs, it covers all of the remaining years and procurement quantities on the contract. If a multi-year procurement contract is canceled, the contractor would generally be paid a cancellation charge that includes: (1) costs, such as a portion of the contractor's preproduction, startup, and facilities costs that would have been spread out over the entire contract as well as other costs incurred by the contractor and subcontractors and (2) a reasonable profit or fee on the costs. Multi-year contracts may provide for a cancellation ceiling, which

caps the government's liability under a cancellation. For DOD, NASA, and the Coast Guard, a multi-year contract which includes a cancellation ceiling in excess of \$135.5 million may not be awarded until the head of the agency gives written notification of the proposed contract and of the proposed cancellation ceiling for that contract to the House and Senate Appropriations and Armed Services Committees. As opposed to a cancellation, a termination for convenience may occur at any time and be for the entire or only part of the contract. Multi-year contracts terminated for convenience would be settled based on the terms of the contract, including any applicable cancellation provisions, and the FAR. In either a cancellation or termination for convenience, the magnitude of the costs is driven by the specific terms of each individual contract. GAO has not evaluated the magnitude of these costs for multi-year procurement contracts in our past work.

3. Are there specific criteria that a DOD program must meet to qualify for multiyear procurements? What are examples of such criteria? If the same eligibility criteria were applied by NASA, how many of today's existing science and human space flight-related contracts would be eligible for multiyear procurements?

Yes, 10 U.S.C. § 2306b, as implemented by the FAR and agency regulations, specifies criteria DOD and NASA must follow to award a multi-year contracts that procure property. Implementing section 2306b(a), FAR § 17.105-1(b) allows the head of the agency at DOD, NASA, and the Coast Guard to enter into a multi-year contract for supplies if

- (1) The use of such a contract will result in substantial savings of the total estimated costs of carrying out the program through annual contracts;
- (2) The minimum need to be purchased is expected to remain substantially unchanged during the contemplated contract period in terms of production rate, procurement rate, and total quantities;
- (3) There is a stable design for the supplies to be acquired, and the technical risks associated with such supplies are not excessive;
- (4) There is a reasonable expectation that, throughout the contemplated contract period, the head of the agency will request funding for the contract at a level to avoid contract cancellation; and
- (5) The estimates of both the cost of the contract and the cost avoidance through the use of a multi-year contract are realistic.

NASA does not currently have any major projects that would be appropriate for multi-year procurement contracts. In general, these contracts are used to buy systems that have low technical risks, stable designs, and longer-term, predictable production rates. Many of NASA's major science projects involve the procurement of a single spacecraft. NASA's human exploration programs that might involve larger quantities over the long-term are still in development and have significant technical risks to address.

4. According to H.R. 2093, the list of expertise required for membership on the Board does not include cost analysis/estimation. In your prepared statement, you indicate that GAO's ongoing and prior work show that NASA needs to improve its cost estimating, scheduling practices, and contractor oversight. Given that the Board is mandated to provide a proposed annual budget based on "the best professional judgement of the Board," in your view, how significant is the omission of cost analysis/cost estimation and related expertise.

Having sound acquisition knowledge would certainly benefit the board given that NASA relies significantly on contractors to execute its mission. However, if members of the Board do not have expertise in cost analysis/estimation, the Board members could choose to leverage this expertise through the appointment of professional staff and limited-term technical and professional staff, as discussed in H.R. 2093.

5. Based on your reading of the H.R. 2093, would GAO have access to the Board of Director meetings, policy and budget discussions, and basis for the budget proposal that the Board

provide to the President? Based on your experience as a government evaluator, who, if anyone, would be able to provide oversight over the Board of Directors?

GAO's access authority comes from 31 U.S.C. § 716(a). Section 716 authorizes GAO to inspect agency records to obtain information necessary to execute its responsibilities. It is not clear that the Board contemplated by this legislation would be considered an agency for purposes of being subject to GAO's access authority. As such, there is a question as to what extent GAO would be able to attend Board of Director meetings and policy and budget meetings, or obtain access to supporting documentation used by the Board to develop its budget proposal.